

# JOURNAL OF CREATION



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**NOAH AND THE FLOOD  
IN ANCIENT EGYPT**

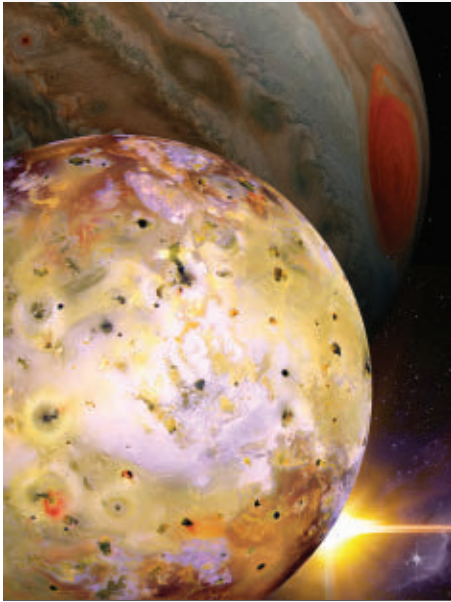
**DID THE PRE-FLOOD WORLD  
RESEMBLE PANGAEA?**

## **IO: VOLCANISM AND YOUNG AGE**

**CIRCADIAN RHYTHMS AND DESIGN**

**HOMO ERECTUS:  
EVIDENCE OF INTELLIGENCE**





# JOURNAL OF CREATION

An international journal devoted to the presentation and discussion of technical aspects of the sciences such as geology, biology, astronomy, etc., and also geography, archaeology, biblical history, philosophy, etc., as they relate to the study of biblical creation and Noah's Flood.

**COVER:** An enhanced mosaic of images of Jupiter's moon Io taken by NASA's Galileo spacecraft on 3 July 1999

**IMAGE:** NASA / JPL / University of Arizona

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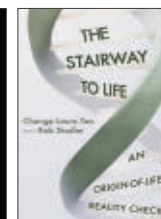
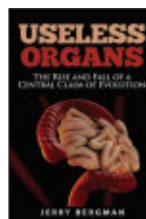
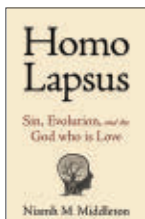
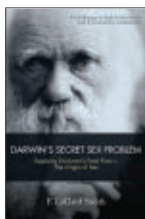


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# Evolutionary ‘proof’ of poor intestine support actually evidence of design

Jerry Bergman

A *Smithsonian Magazine* review lists the top 10 “glaring, yet innately human, imperfections” as a consequence of having evolved. Number four is “a lack of support for the intestines”.<sup>1</sup> North Carolina State University Professor of Biology Robert Dunn explains that once humans began to walk

“... upright, our intestines hung down instead of being cradled by our stomach muscles. In this new position, our innards were not as well supported as they had been in our quadrupedal ancestors. The guts sat atop a hodgepodge of internal parts, including, in men, the cavities in the body wall through which the

scrotum and its nerves descend during the first year of life. Every so often, our intestines find their way through these holes—in the way that noodles sneak out of a sieve—forming an inguinal hernia.”<sup>1</sup>

A critical problem with this reasoning claiming poor design is it fails to mention specifically how the structures that support the intestines are poorly designed and what specifically could be altered to improve the design. The only evidence offered for the claim of poor design is related to pathology, i.e. when things go wrong. Actually, our intestines and other abdominal structures are cradled by a set of strong muscles and accessory structures, including a bone structure called the pelvic girdle. The pelvis bone design “provides somewhat rigid support for muscles engaged in locomotion [e.g. walking, and running]”.<sup>2</sup> The fact is, “Skeletal muscle architecture is the strongest predictor of a muscle’s functional capacity”, meaning in this case that the existing muscle design is the best indicator of its proper role and claims of poor design are suspect.<sup>3</sup> Nonetheless, anything that weakens any part of the healthy pelvis muscle system will also affect

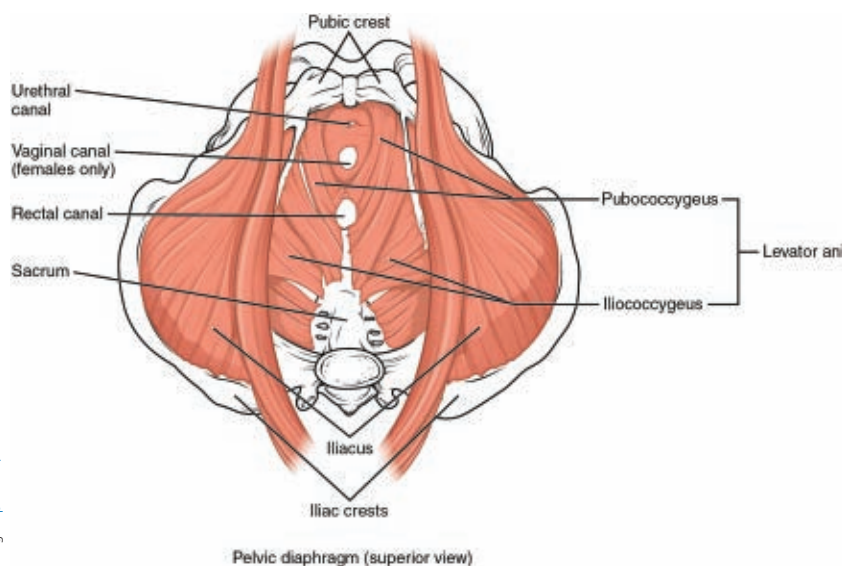
the pelvic floor’s level of support for the contents of the abdominal cavity. The pelvic floor muscles which perform this support role stretch from the tailbone (coccyx) to the pubic bone (front to back) and from one sitting bone to the other sitting bone (side to side).

The pelvic floor muscle set (see figure 1) is normally strong enough in the female to also support a 4.5 kg (10 pound) baby in addition to other organs, as well as assist in the birthing process. If problems develop, they are not due to poor design, but because these muscles are weakened due to disease, loss of muscle mass caused by a poor diet (including extreme diets), marasmus (chronic undernourishment in childhood), ageing, or genetic predisposition due to mutations. Other causes of pelvic floor weaknesses include obesity stressing the pelvic floor; straining caused by chronic constipation; chronic coughing; heavy lifting; high-impact exercise; damage from caesarean section delivery, and even sexual abuse, as well as bladder or bowel problems; and in men, prostate cancer surgery.

Other causes include direct trauma, such as from falling off of a bike or horse; underactive pelvic floor muscles caused by prolonged sitting; or even long-term bed rest which also causes weakness in numerous other muscles.<sup>4</sup> Pelvic floor exercises in some cases can improve muscle tone and prevent the need for corrective surgery.

## Pelvic floor muscle passages

In males, the pelvic floor muscle contains two passages for the urethra and anus, and three in women, for the urethra, vagina, and anus. The pelvic floor muscles normally wrap firmly around these openings to help keep the area around the tubes that pass through them sealed. To ensure this seal is maintained, an extra circular muscle wraps around the opening area for the



**Figure 1.** The pelvic floor muscle set is not a hodgepodge set of internal parts but as the illustration shows it is obviously well designed to support the pelvic organs.



anus, the anal sphincter, and around the urethra, the urethral sphincter.<sup>5</sup>

### The inguinal hernia

The possible consequences of the alleged design flaws mentioned by Professor Dunn included the formation of an inguinal hernia. A hernia is an abnormal protrusion of some organ through muscle or connective tissues, producing a bulge in that area. An inguinal hernia occurs when a portion of the intestine bulges through a vulnerable part of the abdominal wall in association with the inguinal canal that traverses through the wall near the groin. An *indirect inguinal hernia* can occur when the internal inguinal canal is not properly closed at birth, thus is the consequence of a birth defect, not poor design. A *direct inguinal hernia* is when part of the intestine bulges through a vulnerable place in the abdominal muscles *adjacent* to the inguinal wall canal.

Of the many possible causes listed for these problems in the literature, poor design was not mentioned once in the many references that I consulted. Instead, birth defects, disease, injury, and other pathologies were listed. The risk factors for an inguinal hernia include anything that causes an abnormal level of abdominal pressure, such as a chronic excessive amount of gas accumulation and collections of fluid (edema, but could also be blood) in the abdominal cavity or lining. Other causes listed were an enlarged pancreas, liver, gallbladder, or spleen that puts abnormal pressure on the surrounding structures.<sup>6</sup> In all these cases something has to give, and the abdominal wall can serve as a safety valve.<sup>5</sup> Lifting excessive weight and obesity are also risk factors. However, we all know of morbidly obese persons who manage to avoid an inguinal hernia, or persons who lift enormous weight as part of their employment, as myself when younger, that likewise never suffer an inguinal hernia.

Severe tissue inflammation within the abdominal cavity can also cause a chronic increase of abdominal pressure, as can harsh coughing, e.g. caused by tobacco and marijuana smoking or allergies. Constantly straining during bowel movements may also cause inguinal hernias.<sup>5</sup> As an individual ages, muscle tone is typically lost.<sup>7</sup> None of the authorities I consulted mentioned poor design as a cause, as noted, but they did note that the female pelvic floor design is much stronger than that in males in order for women to carry a baby; thus for this and other reasons, women have about a 10 times smaller chance of developing an inguinal hernia than men.<sup>5</sup> The lifetime risk of inguinal hernias is 27% for men and only 3% for women.

This difference is only partly attributed to employment differences (men are far more likely to be involved in heavy work, such as construction) and weight differences (men on average weigh more than women), plus hormone differences between men and women.

Repair rates of inguinal hernia range from 10 per 100,000 in the United Kingdom population to 28 per 100,000 in the United States population.<sup>8</sup> All types of abdominal wall hernias have a prevalence of only 1.7% per year for all ages, and 4% for those over 45 years.

### Comparisons of human and ape pelvic floors

Comparisons of human and ape pelvic floors found that the human pelvic floor, in contrast to the claims of Professor Dunn, is specifically well designed to walk upright. A study comparing rhesus macaque and human pelvic floor muscles found that they “were similar with respect to architecture. However, the magnitude of similarity varied between individual muscles, with the architecture of the most distinct” muscle being that of the human pelvic floor muscle,

specifically the human iliocaudalis which was designed to be “well suited for quadrupedal locomotion”.<sup>9</sup>

### Much yet to be learned

Researchers in this area admit that, to fully understand the pelvis floor’s design, much more research needs to be done, noting:

“The critical barrier that limits progress in identifying the precise cause of PFD [pelvic floor disorders] is our lack of understanding of fundamental mechanisms that lead to pelvic floor dysfunction.”<sup>10</sup>

### Summary

The human pelvic floor design is able to handle a much greater level of stress than what is normally required to carry abdominal load levels of a normal healthy person. Genetic abnormalities, excess weight from obesity, accidents and body abuse, or a combination of these, are common causes of both pelvic floor failure as well as the inguinal hernia problem, not poor design. The pelvic floor cannot be infinitely strong, and rarely causes problems in most healthy adults. Most problems are due to specific health conditions. Furthermore, according to the anatomy and physiology lecture program at the University of Hawaii, the pelvic girdle is well “designed to stabilize and support the body”.<sup>11</sup> In conclusion:

“The human pelvis is a remarkable structure that plays a central role in many critical biological processes, most notably bipedal locomotion, thermoregulation and parturition (childbirth).”<sup>12</sup>

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## The Pinatubo eruption—catastrophic pyroclastic flows and lahars

Andrew Sibley

The eruption of Mount Pinatubo on Luzon Island in the Philippines on 15 June 1991, the second largest eruption in the twentieth century, provides evidence of catastrophic processes that have shaped the land over millennia. It also exemplifies processes that were ongoing during Noah's Flood and in the immediate post-Flood period.

### History of Mount Pinatubo

Mount Pinatubo is an andesite-dacite stratovolcano and part of the Zimbalas mountain range, with a current summit elevation of 1,486 m (reduced from 1,745 m pre-eruption). The amount of material released left a collapsed caldera approximately 2.5 km in diameter, now filled with acidic water (figure 1). Satellite imagery shows the lake surrounded by forest regrowth and a dendritic network of drainage systems ending in alluvial fans, indicative of the erosional power of the lahars (figure 2). The volcano lies on the subduction zone, where the Eurasian Plate passes beneath the

Philippines Mobile Belt. There are various theories for the formation of andesite in volcanoes near subduction zones, some involving the action of water upon hot mantle. A more recent theory suggests andesite may form only a few days before an eruption with the mixing of basalt and rhyolite in the magma chamber.<sup>1</sup>

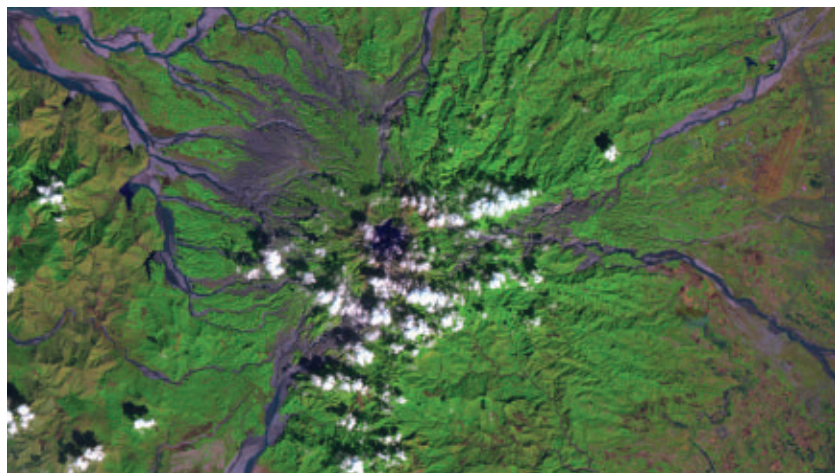
Naturalistic scientists estimate, by K-Ar dating, that Mount Pinatubo is about 1.1 Ma old, although such dating methods have been shown to be unreliable.<sup>2</sup> More modern eruptions are claimed to have started around 35,000 years ago, estimated from varying <sup>14</sup>C measurements: other dates vary between 2,600–3,000, 4,400–5,200, and 8,000 years BP. These are all based on the usual long-age assumptions, but there is evidence that vegetation in volcanic regions may be contaminated with nearby sources of carbon dioxide, which potentially compromises such estimates.<sup>3</sup> Lateral cutting of the 2,600–3,000 years BP deposits along the Abacan River, some 30 km distance from the volcano, reveals tree stumps of 1–1.5 m diameter, still in vertical growth positions, and covered in 5–6 m depth of sediment.<sup>4</sup>

The first eruption of the modern period left pyroclastic-flow deposits between 30 and 100 m in thickness over an area extending to approximately 20 km in radius from the volcano. These are known as the Inararo deposits, perhaps covering 160 km<sup>2</sup> in area, but have been heavily eroded along the dendritic river systems over the period. Estimates suggest total pyroclastic deposition of 25 km<sup>3</sup> in this



Figure 1. The Pinatubo crater lake caldera, March 2018





**Figure 2.** False-colour image of Mount Pinatubo. The crater lake, 2.5 km across, is the small dark area in the middle with grey dendritic river systems radiating outwards providing evidence of lahar floods. The small white areas are clouds (with dark shadows). The image is 35 km across. Tourist access to the crater lake is easiest from the north-northeast, from Santa Juliana along the O'Donnell river (top of image) during the dry season. NASA Landsat image ten years after the eruption—January 2001.



**Figure 3.** Ash, tephra, and pumice naturally form into layers through deposition and pyroclastic flows. This formation is a couple of km from the caldera along the upper part of the O'Donnell River.

event, some five times greater than that of the 1991 eruption.<sup>5</sup>

The eruption immediately prior to the 1991 event, known as the Buag eruption, occurred some 500 years ago, around AD 1500, and was possibly smaller in scale.<sup>5,6</sup> Overall, it is estimated by secular scientists that more recent eruptions have decreased in size. This scenario supports various Flood models in relation to volcanism, which see maximal volcanic activity in the immediate post-Flood period, with a declining trend thereafter.<sup>7</sup> Despite reducing volcanism, the pyroclastic flows from the 1991 eruption filled existing valleys with ash, and larger material to a depth of up to 200 m.<sup>8</sup> The rock formations around the volcano reflect deposition from ashfall

and pyroclastic flows from multiple eruptive events, and shows evidence of natural layering in a matter of minutes (figure 3).

### The 1991 eruption and its effects

Like the Mount St Helens volcanic eruption of 18 May 1980, the legacy of the Mount Pinatubo eruption highlights layers forming naturally in pyroclastic flows and ash deposition. Subsequent reworking of the ash has occurred with flash flooding and mud flows, known as *lahars*, which have proved more dangerous to life than the eruption itself. Floods have left wide, flat valleys in the lower mountain range and steep canyons at higher elevations

with reworked deposits measurable in metres or tens of metres. It is estimated that 10 km<sup>3</sup> of material was ejected into the atmosphere in the June 1991 eruption, with around half of this (5–7 km<sup>3</sup>) falling in the immediate region of the volcano and transforming the landscape. Ash and dust rose 35 km into the stratosphere, along with the release of 20 million tonnes of SO<sub>2</sub>—sufficient to cool the planet by 0.5°C for two years.<sup>4,8</sup>

Unconsolidated pyroclastic deposits are eroded quickly through the action of rainwater, such as particularly occurs during the monsoon and typhoon period in southeast Asia (typically June to October). Rainfall intensity can exceed 50 mm (2 in) per hour. This leads to *lahars*, flash flooding with suspended mud flows from the unconsolidated sediment, that travel at high speed many tens of kilometres from the source. These sometimes bury villages and towns in their path in thick layers of reworked deposits. The mud flows may be 10 m in depth and 100 m wide, eroding into the surrounding cliffs and so increasing in volume as they flow. Deposition depths of fresh sediment in alluvial fans are typically 1–5 m for each event. Estimates consider that up to 3 km<sup>3</sup> of material was carried into the area surrounding Pinatubo by lahars in the first decade after the eruption, with devastating consequences for surrounding towns and villages.<sup>4</sup> More people died from such events than from the eruption itself. Boulders with diameter 1.5 m are not uncommon in lahar flows and in other mud flows. For instance, at the Nevado del Ruiz volcano, 7-m-diameter boulders have been carried hundreds of metres.<sup>4,9</sup>

Water-induced lahars can travel at speeds of 30–60 km/h (20–40 mph) and contain 40–90% solid debris of ash, pumice, and other rocks. Interestingly, higher percentages of solid material to water enable faster downslope velocity due to increased laminar flow. The river valleys in the lower parts of Pinatubo are cross-sectionally flat with shallow slopes, and are hundreds of





**Figure 4.** Lower down the O'Donnell River the valley is wide and flat with steep, white cliffs highlighting the action of lahars and flash floods. The white cliff face shows evidence of layering in the pyroclastic flows and subsequent erosion.



**Figure 5.** Higher up the O'Donnell River the valleys are steep with recent canyon formation.

metres wide, with vertical cliffs at their edge, for instance along the O'Donnell River near Santa Juliana (figure 4). The normal river volume flow is evidently small compared to the scale of the flash floods and mud flows. Valleys are steeper and narrower higher up the volcano with recent canyon formation evident over the past 30 years (figure 5). The fresh sediment is denuded by rainfall forming new valleys and canyons in a matter of a few days and months, while the ash layers can be traced across a wider area.

### Summary

Like the Mount St Helens eruption in America, the Philippines' Pinatubo eruption of 1991 highlights catastrophic processes that are involved in shaping the landform in periods ranging from minutes to several years, reflective of events during and after Noah's

Flood. Layers measurable in tens of metres can be seen to form naturally in fast-moving pyroclastic flows. Later heavy rainfall leads to high rates of erosion of unconsolidated material, and massive waterborne transport of material to lower altitudes and fresh deposition measurable in metres to tens of metres. Overall, this is estimated to have involved the movement of several cubic kilometres of material over a period of a decade. Towns and villages have been inundated, and forest trees have historically been buried vertically *in situ*. Short periods of time are necessary for the formation of conformable layers, while longer periods of time, measurable in days, months, and years, lead to significant erosion, with valley and canyon formation and sediment deposition on alluvial plains. This is a testimony to the destructive power of catastrophe, and it shows that many types of formations normally

associated with uniformitarian processes can be explained in the context of a cataclysm—much like Noah's Flood and its immediate aftermath.

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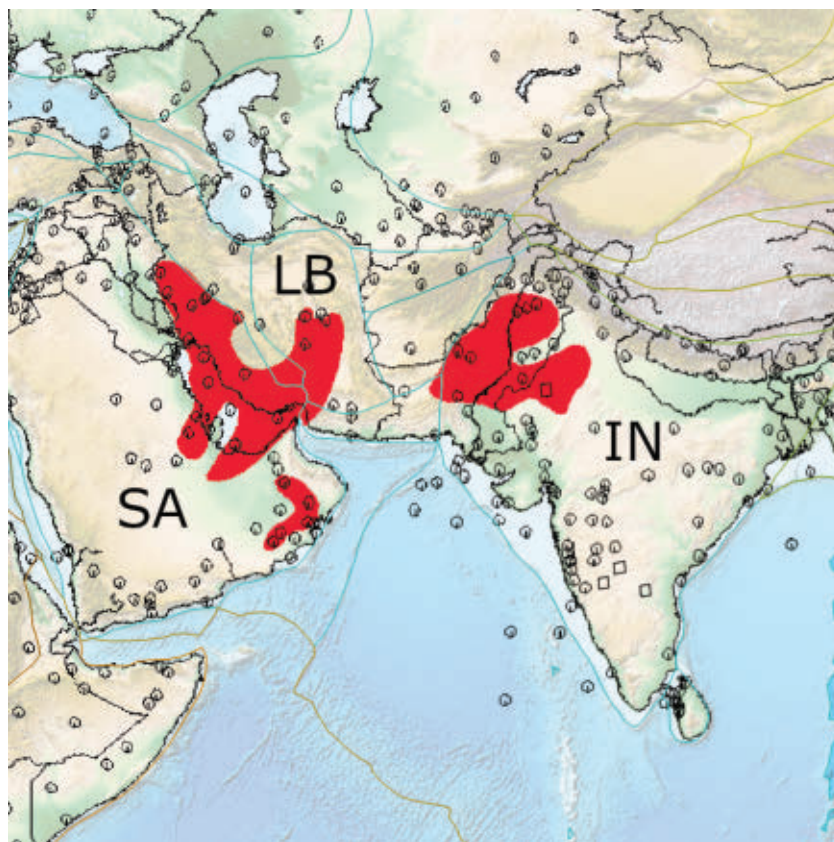
## The pre-Flood world resembled Pangaea

Timothy L. Clarey and  
Davis J. Werner

Secular geologists have inferred several pre-Pangaea supercontinents, including Greater Gondwana or Pannotia (involving mostly the southern continents) and before that Rodinia. Greater Gondwana (Pannotia) is the so-called transitional continental configuration between Pangaea and Rodinia. Pangaea is claimed by secular scientists to have formed about 350 Ma years ago, Greater Gondwana about 500 Ma ago, and Rodinia about 900 Ma ago.<sup>1</sup>

Debate exists over the best pre-Flood continental configuration, with some creation scientists advocating for an initial created supercontinent called Rodinia that many accept was centred at the South Pole.<sup>2</sup> We have advocated for something close to Pangaea and have it centred closer to the equator.<sup>3</sup> John Baumgardner has introduced a slight twist to the debate, in an attempt to explain the paleomagnetic data. He chose to call the pre-Flood configuration Pannotia, but in fact it closely resembles Pangaea in its configuration.<sup>4</sup> However, he placed his pre-Flood Pannotia close to the South Pole, similar to the location of Rodinia.<sup>4</sup>

In our research on the pre-Flood world, we used a slightly modified Pangaea configuration because it has the most empirical geological evidence supporting it, including the best fit of the modern continents, especially across each side of the Atlantic Ocean.<sup>5</sup> We placed a narrow sea (300–500 km) between North America and Africa/Europe, allowing for limited plate subduction, an early Flood closure of



**Figure 1.** Map of the present configuration of south-west Asia including Saudi Arabia (SA), India (IN), and the Lut Block comprising eastern Iran (LB). The Precambrian salt-rich rocks are shown in red. Stratigraphic data control points are shown as small circles. Note that the Precambrian salt-rich rocks are presently separated by Afghanistan.

the pre-Atlantic, and the formation of the Appalachian/Caledonian mountain belts.<sup>6</sup> We included this pre-Atlantic sea based on subducted plate remnants that diminish beneath the Appalachians below 300 km, which support this narrow-sea interpretation.<sup>7</sup>

Baumgardner has recently suggested a slight variation on the two dominant pre-Flood configuration models.<sup>8</sup> He acknowledges that the

“... vast number of paleomagnetic determinations made over the past 70 years point overwhelmingly to the conclusion that the continental regions now in the northern hemisphere, especially Europe and North America, were located not far from the south magnetic pole when their early Paleozoic igneous rocks crystallized.”<sup>8</sup>

However, he further acknowledged that the paleomagnetic data is not diagnostic in itself, and that either 1) the magnetic pole of the pre-Flood world could have moved about 110° northward along today’s prime meridian early in the Flood, or 2) the continents themselves moved 110° along this same path early in the Flood.<sup>8</sup> Both of these solutions would satisfy the observable paleomagnetic data. Other than that, his Pannotia configuration closely resembles Pangaea, with an already intact Gondwana.<sup>4</sup>

Of these two scenarios, we propose the first scenario is more likely, that only the magnetic field migrated rapidly northward in the early Paleozoic (early Flood), leaving the physical continents close to their pre-Flood configuration near the equator, barring



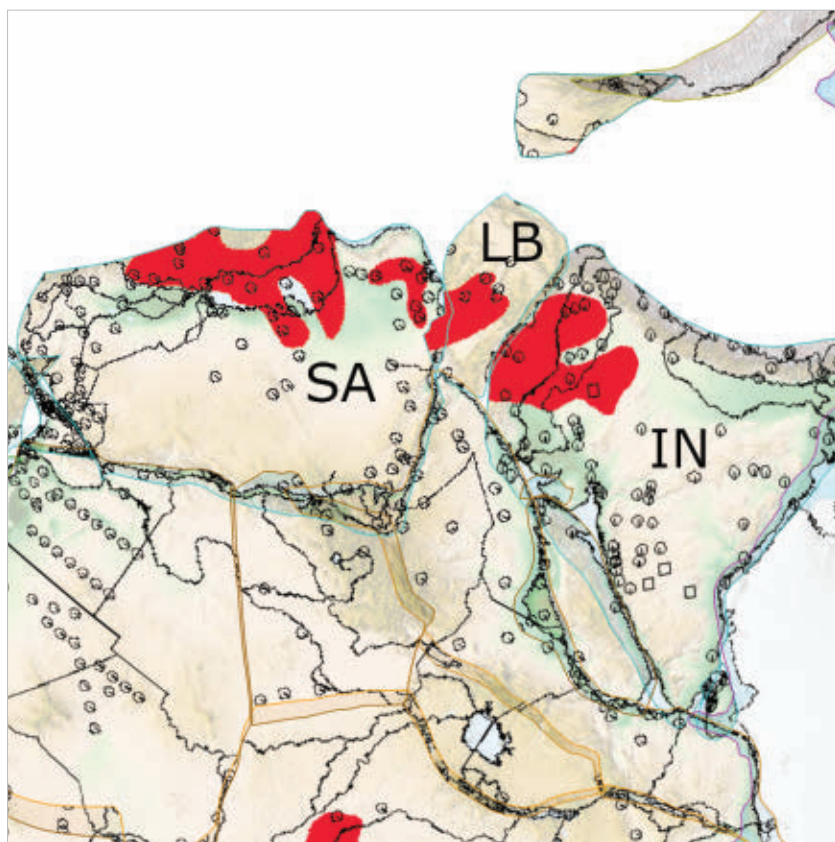
some initial plate motion. This suggests that the magnetic poles may have been close to the equator prior to the Flood or had rapidly migrated to that position at the onset of the Flood event. The continents themselves did not have to move rapidly in this interpretation, just the magnetic poles did.

However, the question about which pre-Flood configuration to use remains unresolved. Should it be more like Rodinia or Pangaea? Should it be centred at the equator or centred at the South Pole? We attempt to answer these questions by examining some unusual Late Precambrian rocks found in southern Asia and the Middle East. We also assess the amount of new sea-floor required in each model and finally test our reconstruction against a fossil assemblage recently discovered in Antarctica.

### Precambrian salt better fits Pangaea

We have recently mapped out the extent of a massive amount of Precambrian salt-rich rocks in the Middle East, Pakistan, and India (figure 1). This salt bed extends from the Persian Gulf (Hormuz Evaporates) to Pakistan (Salt Range Formation) to western India (Hansera Evaporates).<sup>9–11</sup> These various salt-rich units have been conventionally dated as Neoproterozoic, falling in the age range of 540–950 Ma years old.<sup>9,10</sup> The Salt Range Formation has been described as a mass of unstratified halite with occasional thin dolomite beds, capped by both gypsum and anhydrite.<sup>9</sup> These various formations vary between 1,800 and 3,000 m thick, including the non-halite units.<sup>9</sup>

Finding thick salt-rich layers in rocks prior to the Cambrian is rather unusual globally. Exactly why these salt-rich rocks formed in a Flood model just prior to the Sauk Megasequence is still unclear. As these Precambrian salt-rich rocks are claimed by secular geologists to be approximately



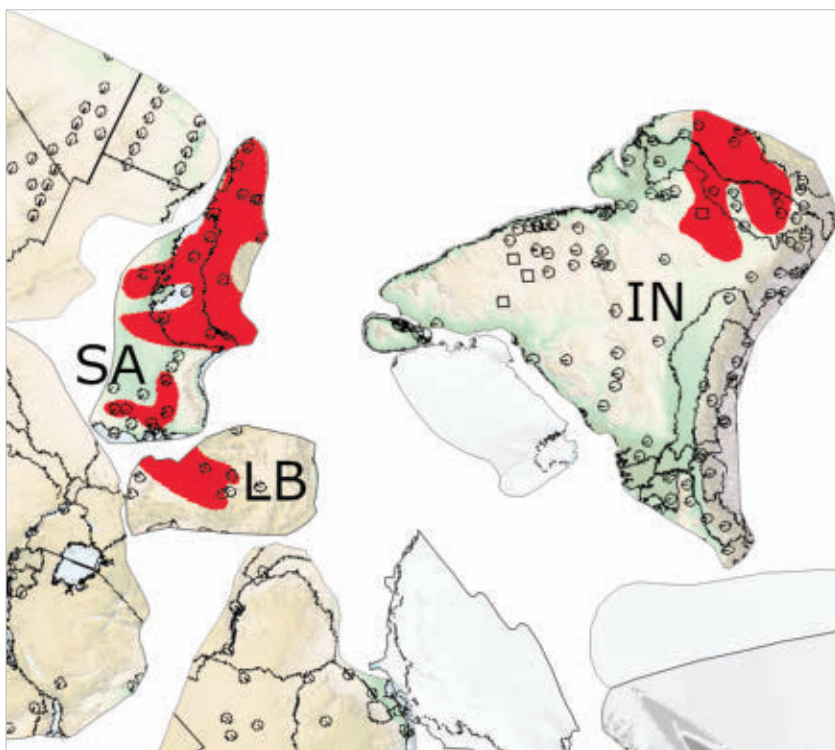
**Figure 2.** Map of the Pangaea-like configuration (secular date of 350 Ma) of south-west Asia including Saudi Arabia (SA), India (IN), and the Lut Block comprising eastern Iran (LB). The Precambrian salt-rich rocks are shown in red. Stratigraphic data control points are shown as small circles. Note that the Precambrian salt-rich rocks are all in alignment and close together, implying a common source for the salt at the time of this configuration. This appears to show the best fit of the salt beds, indicating the salt was likely deposited while the continents were in the Pangaea-like configuration.

the same age as Rodinia, we can use their extent to test the validity of the Rodinia reconstruction. In other words, do the salt deposits fit the Rodinia reconstruction?

Figure 1 shows the current extent and thicknesses of the salt-rich layers across the Middle East and southern Asia. Figure 2 shows the reconstructed Precambrian salt-rich formations when placed in a configuration similar to Pangaea. Figure 3 shows the approximate locations of these same salt deposits in a Rodinia reconstruction. After examining these maps, it seems quite clear that the Pangaea (including the Greater Gondwana or Pannotia) reconstruction is the better fit. This reconstruction places the salt-rich rocks in the same approximate location

spanning the north-eastern Saudi Arabian Peninsula and the subcontinent of India. Unfortunately, Greater Gondwana and Pangaea are very similar in the Southern Hemisphere, so it is difficult to differentiate the two. Nonetheless, they are both good matches of the Precambrian salt-rich units in the Middle East, Pakistan, and India (figure 2).

The claimed older Rodinia configuration shows a poor match of the salt deposits across this region (figure 3). Admittedly, it is possible that there may have been multiple random locations of salt deposition simultaneously in various locations of the globe at the time of deposition. However, the simplest, and usually the best solution to explain these salt deposits is that they



**Figure 3.** Map of the Rodinia configuration (secular date of 900 Ma) of south-west Asia including Saudi Arabia (SA), India (IN), and the Lut Block comprising eastern Iran (LB). The Precambrian salt-rich rocks are shown in red. Stratigraphic data control points are shown as small circles. Note that the Precambrian salt-rich rocks are presently separated by an area of vast oceanic crust at the time of this configuration. This appears to be the worst fit of the salt beds, indicating that the salt was least likely deposited while in the Rodinian configuration.

formed in the same approximate location at the same time.

We conclude that Pangaea (at least the southern part called Gondwana) was already in existence when these massive Neoproterozoic salt-rich rocks were being deposited. This finding confirms and validates our earlier pre-Flood continental interpretation for the pre-Flood world that used a modified Pangaea.<sup>6</sup> Rodinia is merely a secular uniformitarian hypothesis that doesn't conform well to the actual rock data.

### Rodinia requires too much oceanic crustal subduction

Another reason we favoured a Pangaea located near the equator is the youthfulness of the modern oceanic crust. The denser pre-Flood oceanic crust was nearly completely consumed by subduction during the Flood. Rapid

seafloor spreading created a completely new and lower density oceanic crust (lithosphere really) as a consequence. It was the density contrast between the heavier, colder, original oceanic crust (the lithosphere) and the underlying less dense and hotter mantle that allowed the runaway subduction process to proceed. The density difference served essentially as the 'fuel'. Geophysicist John Baumgardner described it as "gravitational energy driving the motion" of the plates.<sup>12</sup>

The global stratigraphic data we have compiled indicate only a limited rise in sea level occurred during the early Paleozoic.<sup>13</sup> These strata are the least extensive in terms of volume, surface area, and average thickness compared to the later Mesozoic and Cenozoic deposits.<sup>14</sup> These data indicate that runaway subduction only began in selected locations first, like

along the edge of the pre-Atlantic Ocean and possibly in the western Pacific. Early Paleozoic strata were likely caused by tsunami-like waves that went crashing across vast shallow seas that existed in the pre-Flood realm.<sup>3,6</sup> Later in the Flood, we see stratigraphic evidence that runaway subduction and catastrophic seafloor spreading were operating on a more massive scale, spreading sediments across even more extensive areas of the continents including the highest hills.<sup>13,14</sup> The newly created oceanic lithosphere served to push up the seafloor until the tsunami waves were able to circumvent the globe at the end of the Mesozoic. There was no geophysical means or reason to stop the catastrophic plate motion until the original oceanic lithosphere was fully consumed. At that moment, the newly created, more buoyant lithosphere ceased subducting, bringing plate motion to a virtual standstill. As a result, we only witness small residual plate motions of centimetres per year today.

A pre-Flood world that resembled Rodinia (or Pannotia), centred at the South Pole, would have required nearly all the oceanic crust to be consumed twice. The first time would have been during the breakup of Rodinia, moving the continents into the configuration of Pangaea. The later split of Pangaea would have required a second episode of near-complete consumption of the oceanic crust to produce the current global configuration. Geophysically, the first breakup of Rodinia and reconfiguration into Pangaea would be possible, but it would also have consumed all the denser pre-Flood oceanic crust in the process. A second move would then be rendered nearly impossible since any significant amount of new oceanic crust created (to break up Rodinia) would not have the necessary density contrast to fuel a second episode of subduction (to break up Pangaea). As mentioned above, it is the consumption of the cold, more dense pre-Flood oceanic crust that caused



runaway subduction in the first place.<sup>12</sup> Therefore, if there had been a Rodinia, we would still be in a Pangaea continental configuration today.

### Testing the Pangaea-like configuration with fossils

Recently, a drilling ship extracted a core from West Antarctica's Amundsen Sea, finding fossils claimed to be from an ancient rainforest.<sup>15</sup> The sediment in the core was dated between 84–94 Ma old, placing it in the Cretaceous System.<sup>15</sup> Secular plate reconstructions at the presumed time place this part of Antarctica very close to the South Pole, at about 82°S latitude.<sup>15</sup>

How could a temperate rainforest exist this close to the South Pole and survive through 4+ months of darkness each year? Even in a Flood model, there are equally baffling climate questions if other pre-Flood configurations are used instead of Pangaea. A configuration like Rodinia places Antarctica and most of the continents near the South Pole.<sup>2</sup> This leaves much of the continental mass in total darkness for several months each year, assuming a tilt to the earth was in effect to mark the seasons (Genesis 1:14).

In contrast, our Pangaea-like configuration has these Antarctic plant fossils growing near 45°S latitude in the pre-Flood world, about the equivalent to southern New Zealand today.<sup>6</sup> These Cretaceous plants were simply buried near their place of origin, later in the Flood, as the waters were reaching their zenith across the globe.<sup>16</sup> Not surprisingly, these same types of trees and flowering plants are found in modern-day New Zealand. As Ashley Strickland reported: “The forests were similar to those now found on New Zealand's South Island, the researchers said.”<sup>17</sup>

### Concluding thoughts

A lush, temperate rainforest near the South Pole is not a mystery if a Pangaea-like pre-Flood supercontinent

was in existence since Creation Week. These plants were simply growing in a pre-Flood mid-latitude location, far from the South Pole, and then were rapidly moved to their present position during the catastrophic plate activity of the Flood. These rainforests never did grow near the South Pole.

In summary, a pre-Flood Pangaea-like configuration best explains the fit of the Precambrian salt deposits in the Middle East/Asia and similarly, makes the most sense of the recent discovery of the Cretaceous rainforest found in Antarctica. And it can explain the paleomagnetic data by assuming only a magnetic polar wander, and not a mechanical wander.

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# What is the meaning of limestone–marl alternations?

Michael J. Oard

Secular scientists love cycles in sedimentation, and there are many types of cycles at different vertical scales. Varves are defined as regularly repeating two or more sublayers, such as alternating silt and clay, deposited in one year. Rhythmites are two or more sublayers that are *not* necessarily deposited in one year, and in some cases, there can be numerous rhythmites deposited in one year. Varves occur today in lakes at the edge of glaciers and even in some non-glacial lakes.

A favourite for secular scientists is varves because they believe they can

count varves in one location and correlate them to varves in other locations to build up an Ice Age chronology of thousands of years. Varve dating has been used to estimate the number of years since the ice sheets melted in Scandinavia and North America.<sup>1,2</sup>

So-called varves are also prevalent throughout the geological column and are called varvites if they are lithified. As an example, Bradley estimated 5–8 million ‘varves’ in the Green River formation.<sup>3</sup> Since the Green River Formation is very likely a Flood deposit,<sup>4,5</sup> there must have been processes causing numerous rhythmites quickly in the Flood.

Such pre-Pleistocene rhythmites and other cycles have been used to push the Milankovitch mechanism well beyond the idea of showing the cyclicity of multiple Pleistocene ice ages.<sup>6</sup> Because the Milankovitch mechanism is applied to oscillating variables in deep-sea cores, secular scientists now claim there were 50 ice ages of variable intensities during the 2.6 million years of the Pleistocene.<sup>7</sup> It is only the

‘last’ ice age that would correspond to the biblical Ice Age caused by the Flood. Glacial deposits on land predominantly show one ice age.<sup>8</sup> Where several tills (ice-age sediments) are superimposed with non-glacial sediments like sand or gravel between, such as near the edge of the ice sheet, the deposits can be explained by fluctuations during one ice age, just as what is observed with modern glaciers.<sup>9</sup>

## Limestone–marl alternations used to support Milankovitch cycles

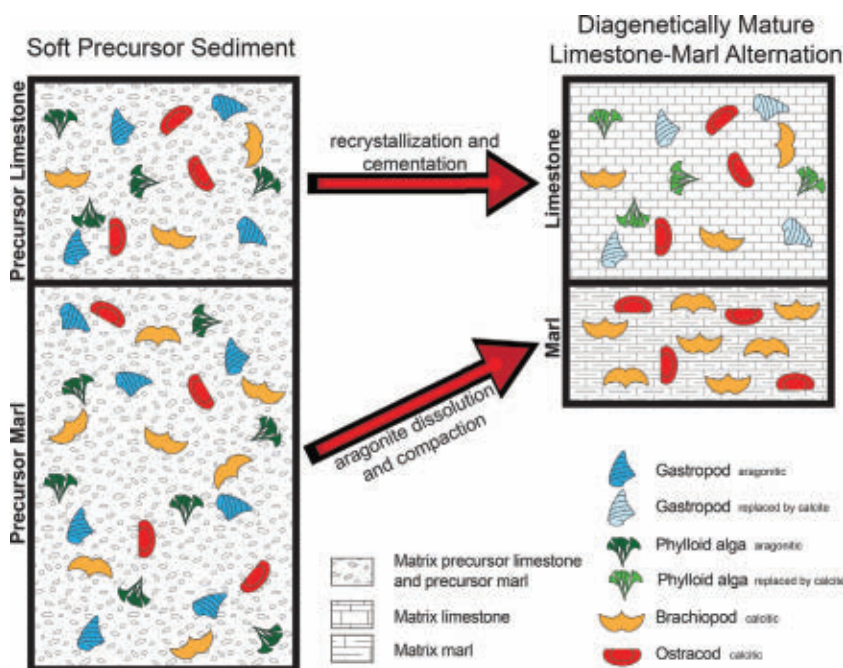
Limestone/marl alternations (LMA) are another type of cyclic sedimentation that can show hundreds of couplets. Marl is loosely defined as a muddy limestone usually with greater than 35% fine-grained particles.<sup>10</sup> LMA are then purer limestone alternating with less pure limestone. Marls are softer, less cemented, and compact more with overburden, compared to limestone. Each component can have different proportions of limestone and fine-grained sediments. These alternations are commonly assumed to record cyclic sedimentation caused by the astronomical or Milankovitch mechanism (astrochronology):

“Limestone–marl alternations (LMA) are rhythmical successions of carbonate-rich sedimentary rocks. They are often assumed to record cyclic sedimentation linked to Milankovitch cycles . . . . Numerous astrochronological and isotopic analyses, as well as environmental reconstructions, are based on data derived from LMA.”<sup>11</sup>

## Origin of LMA unknown

However, researchers really do not know how LMA originate:

“In spite of the importance of LMA for a range of questions in geosciences, it is not unequivocally understood how they originate. . . . Interpreting a LMA and its genesis correctly is as important as it is difficult.”<sup>12</sup>



**Figure 1.** The early diagenesis model of a uniform sediment.<sup>15</sup> During compaction, the aragonite fossils in the future limestone sublayer are recrystallized to calcite with rapid lithification and little compaction. The future marl is compacted with the total dissolving of the aragonite fossils and the reorientation of the fossils.



As such, this is yet another way that uniformitarian analogies between present and past break down.

### LWAs can form by diagenesis

Some researchers urge caution in using LMA since diagenesis can affect, or even *produce*, the alternation, and therefore the ‘right’ rhythmites must be carefully chosen for Milankovitch analysis.<sup>13</sup> Diagenesis is alteration of sediment due to chemical, physical, and biological processes that act on sediment between deposition and lithification, excluding alteration due to surficial weathering and metamorphism.<sup>14</sup> Furthermore, carbonate rhythmites are especially prone to diagenesis, and as a result it is difficult to detect any primary cyclicity.<sup>12</sup>

The timescale must first be estimated by radioisotope, paleomagnetic, and biostratigraphic methods to see if the sequence is in the right ballpark, chronologically. Then they need to determine if the cyclicity is primary, originating from sedimentation, as opposed to an artificial cyclicity formed during diagenesis. During this process they would automatically estimate if the cyclicity is close to one of the Milankovitch frequencies. Thus, picking the right sequence and dating the sequences is likely a subtle exercise in circular reasoning.

Because carbonates are especially prone to diagenesis, such as the addition of magnesium ions from fluid flow to form dolostone, carbonate can be redistributed vertically (i.e. it can move up or down within the sediment). It is, therefore, possible that diagenesis can actually cause the LMA alternations from an originally homogeneous muddy limestone, and that the LMAs have nothing to do with Milankovitch cycles.

### A test shows that LMA, at least many, are diagenetic

Although tests are available that can check to see whether LMAs are suitable

for fine-tuned dating by astrochronology, a new test was recently derived to see whether diagenesis can explain the alternations.<sup>15</sup> Two models, late diagenesis and early diagenesis, were ingeniously tested. The early diagenesis model, which assumes differential diagenesis, worked.

The researchers tested their idea by starting with a homogeneous soft muddy limestone sediment containing small fossils (figure 1). The aragonite fossils in the limestone changed to calcite as the future limestone sublayer cemented early with little compaction (top part of figure 1). Aragonite is a different metastable atomic arrangement of calcite. The sublayer that becomes marl is compacted with total dissolution of the aragonite fossils, which are reoriented during compaction while being buried (bottom part of figure 1).

The researchers gathered four sets of thin sections from Paleozoic carbonate formations. This model passed three tests for the early diagenesis model: (1) recrystallized aragonite fossils appear only in the limestone, (2) the calcite fossils are the same in marl and limestone, and (3) the fossils in the marl have been reoriented due to compaction.

Therefore, a homogeneous muddy limestone can be diagenetically altered to form LMA cycles that have nothing to do with Milankovitch cycles. This would disqualify most LMAs from showing pre-Pleistocene Milankovitch cycles:

“If further diagenetic process can distort an originally homogeneous sediment until it is undistinguishable from an original difference in lithology, it may become impossible to discern whether the LMA rhythmicity reflects changing depositional conditions [from Milankovitch cycles] or diagenetic processes.”<sup>16</sup>

And, worse yet, many researchers do not bother to check for possible diagenesis: “What is more, many scientists still do not consider differential diagenesis in their work on LMA.”<sup>15</sup> Based on this research LMA should not be used for showing Milankovitch cycles.

### Creation science deductions

Deriving Milankovitch cycles from LMAs is a house of cards and very likely based on circular reasoning. Not mentioned in much research on pre-Pleistocene Milankovitch cycles is how such weak cycles can be translated into such dramatic changes in deposition from purer carbonate to a muddy carbonate, if the LMA cycles are really primary.

Sedimentary rocks are commonly cyclical. These can be explained by abundant internal waves during the Flood.<sup>17</sup> Internal waves are propagating waves on any density discontinuity. They are common today in the oceans, but during the Flood they would be orders of magnitude more common. These have the potential to explain the so-called varvites and other types of rhythmites.

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## Evolutionary confusion on when modern humans split from Neandertals

Michael J. Oard

Evolutionists are still debating many aspects of their belief that an ape-like creature evolved into modern man. It is interesting that when a new candidate for fossil man is found, the ancestor chart is changed. Because of the competitive drive to find the missing links, evolutionists are happy to use evidence that is fragmentary, equivocal, and which rests on many evolutionary assumptions.<sup>1</sup>

The most recent presentation is that both modern man and Neandertals arose from a common ancestor, *Homo heidelbergensis*. The split supposedly occurred roughly 400 ka (thousand years ago) in the evolutionary timescale.<sup>2</sup> However, genetic evidence, which seems to always push splits from common ancestors further back in time, suggests the split from *Homo heidelbergensis* was between 550 and 765 ka, although the genetic evidence is based on contested assumptions:

“Divergence times inferred from genomic data are highly dependent on the mutation rate and generation time estimates, which are still debated (18). Small variations of these parameters can result in very different estimates of the divergence time between two species. If these nuances are not considered, then a strict read of the values provided by aDNA [ancient DNA] analyses can give rise to radically different interpretations of the fossil record.”<sup>3</sup>

The researcher, Aida Gómez-Robles, therefore turned to comparisons between hominin fossil teeth over time.

### Much earlier split claimed

Exactly when humans split from Neandertals is unknown and controversial within evolutionary circles: “The origin of Neanderthal and modern human lineages is a matter of intense debate.”<sup>3</sup> Based on Neanderthal teeth from a Spanish cave, Sima de los Huesos, it is now claimed that the divergence occurred more than 800 ka within the evolutionary timescale.<sup>4</sup> Supposedly during hominin evolution, tooth crowns changed in size and shape at a ‘steady’ rate and this rate would mean the common ancestor lived more than 800,000 ka ago:

“The Neanderthal teeth, which date to about 430,000 years, could have evolved their distinctive shapes at a pace typical of other hominids only if Neanderthals originated between 800,000 and 1.2 million years ago.”<sup>5</sup>

This would mean that modern humans may have been on planet Earth for 1 Ma, which is much greater than previous estimates.

To determine a rate of change in hominin teeth, Gómez-Robles used two different phylogenetic frameworks because of the *lack* of consensus on hominin phylogenetic relationships among evolutionists (figure 1). Figure 1B is an ensemble of 100 phylogenies out of 60,000 possible ones. She analyzed teeth from the same location in the jaw from many ‘ape-man’ fossils and produced a rate of change of size and shape over time. Since Gómez-Robles used ‘ancestors’ that dated older than 3 Ma ago in her phylogenies, the result was a very slow rate of change. After comparing the teeth of the Sima de los Huesos cave Neandertals,<sup>6</sup> she arrived at her conclusion.

However, there are variables not included in the analysis, such as hybridization:

“Another factor that may have potentially affected dental evolution in SH [Sima de los Huesos] hominins is hybridization. On the basis of genetic analyses, it is now



confirmed that hybridization happened between Neanderthals, modern humans, and Denisovans (30, 31), probably quite often.”<sup>7</sup>

Regarding hybridization, teeth characteristics would seemingly be variable and not form a gradual change in shape and size. Such ‘hybridization’ indicates that these three ‘species’ should really just be considered varieties of modern man. This would agree with new research that shows Neandertals were as sophisticated as modern humans.<sup>8,9</sup>

Other paleoanthropologists have generally accepted the new result, such as well-known paleoanthropologist Bernard Wood of George Washington University in Washington D.C.<sup>5</sup> One researcher cautioned: “But it’s unclear if Gómez-Robles’ contention that hominid teeth evolved at a steady pace will hold true, Bailey says.”<sup>10</sup>

### Implications

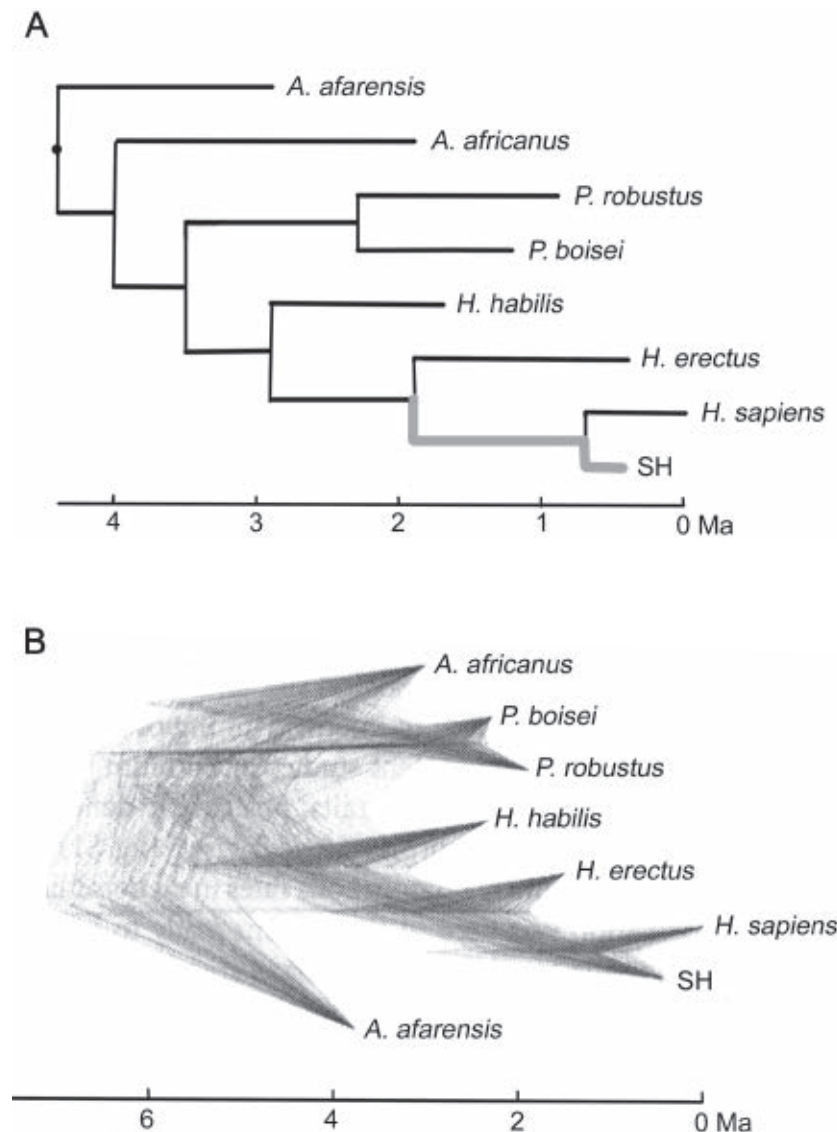
The evolutionary analysis always assumes human evolution and deep

time, along with other assumptions. There is abundant evidence against ape-to-man evolution gleaned from their own writings, creation research, and from fossils.<sup>1</sup> From a biblical perspective all or at least most of these ‘hominin’ fossils<sup>11</sup> would be considered as early post-Flood when they were struggling to survive during the Ice Age. We reject all of the uniformitarian dates, at least in an absolute sense.

There is much controversy in the area of human evolution with variable evolutionary phylogenies based on imperfect genetic data. Assumptions were also required in the fossil teeth analysis, including the existence of separate human species. Since hybridization (interbreeding) apparently was common between all these so-called species of man, this would support the creation science contention that all the so-called hominid species represent varieties of people groups. This supports much creation research that people are people and apes are apes, and there are no missing links between the two.<sup>1</sup>

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**Figure 1.** The two phylogenies used to estimate the rate of growth of hominin teeth over time. B is a randomly selected sample of 100 phylogenies out of 60,000 suggested phylogenetic relationships (modified by Melanie Richard).<sup>12</sup>

# Hiccups— evolution evidence or a designed protection response?

Jerry Bergman

One evidence presented to supposedly document evolution is hiccups. For example, a YouTube video titled ‘How DNA Proves Evolution is Real’<sup>1</sup> lists the tailbone, which the announcer claims proves humans evolved from a tailed animal; ear muscles, which prove we evolved from animals that can move their ears; the third eyelid, which is given as proof we evolved from animals with nictitating membranes such as lizards; and goosebumps, which we share with apes, that didn’t lose their body hair as we supposedly did.<sup>2</sup>

Then hiccups are also given as compelling evidence for evolution, which the film claims traces our evolution back to fish a half-billion or so years ago. Hiccups, the video claims, result from a brain signal that the earliest fish which ventured onto land used to squeeze water through their gills upon returning to water.<sup>1,3</sup> A *Smithsonian Magazine* article listed hiccups as first in “The top ten daily consequences of having evolved.”<sup>4</sup> North Carolina State University Professor of Biology Robert Dunn explains:

“The first air-breathing fish and amphibians extracted oxygen using gills when in the water and primitive lungs when on land—and to do so, they had to be able to close the glottis, or entryway to the lungs, when underwater. Importantly, the entryway (or glottis) to the lungs could be closed. When underwater,

the animals pushed water past their gills while simultaneously pushing the glottis down. We descendants of these animals were left with vestiges of their history, including the hiccup.”<sup>4</sup>

When hiccupping, Dunn writes that humans supposedly

“... use ancient muscles to quickly close the glottis while sucking in (albeit air, not water). Hiccups *no longer serve a function*, but they persist without causing us harm—aside from frustration and occasional embarrassment. One of the reasons it is so difficult to stop hiccupping is that the entire process is controlled by a part of our brain that evolved long before consciousness, and so try as you might, you cannot think hiccups away [emphasis added].”<sup>4</sup>

The article concludes hundreds of useless or poorly designed organs exist in the human body. Specifically, it claims that humans

“... are full of the accumulated baggage of our idiosyncratic histories. The body is built on an old form, out of parts that once did very different things. So take a moment to pause and sit on your coccyx, the bone that was once a tail. Roll your ankles, each of which once connected a hind leg to a paw. Revel not in who you are but who you were. It is, after all, amazing what evolution has made out of bits and pieces.”<sup>4</sup>

Evolutionists have thus proposed that hiccups are an evolutionary remnant of our earlier amphibian respiration system. An article by the well-known British TV presenter and medical doctor, Michael Mosley, adds: “It may seem strange that humans have evolved from fish, but the evidence can be found not just in fossils but also within our own bodies.”<sup>5</sup> He explains:

“Charles Osborne has the dubious honour of holding a record for the longest recorded bout of hiccups—68 years’ worth, from 1922 to 1990. It seems that again it is

our fishy ancestors who are partly to blame. A hiccup is caused by a spasm of the diaphragm, a big muscle in the chest, followed by an involuntary gulp. Both these actions have watery roots.”<sup>5</sup>

He goes on to note that the comparison of humans with fish is anything but straightforward because the

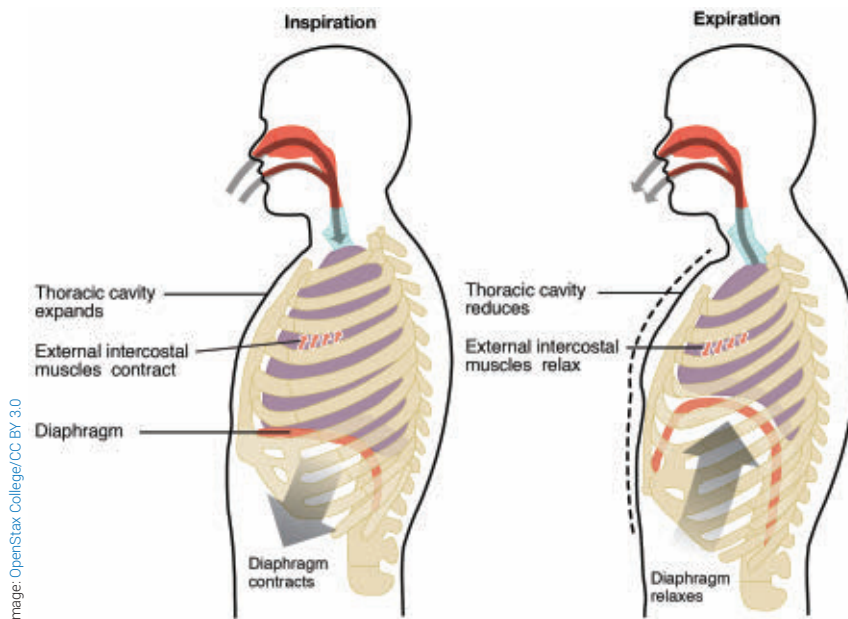
“... nerves that activate breathing take a short journey from an ancient part of the brain, the brain stem, to the throat and gills. In us, it is more complicated. To breathe properly, our brain stem has to send messages not just to the throat, but down to the chest and diaphragm. This complex arrangement means that the nerves are prone to spasm, which can initiate hiccups. Once a hiccup has started, it is kept going by a simple motor reflex that we seem to have inherited from an amphibian ancestor.”<sup>5</sup>

His explanation for this conclusion is that “the nerve controlling this reflex served a useful purpose, allowing the entrance to the lung to remain open when breathing air but closing it off when gulping water—which would then be directed only to the gills”. But for “humans and other mammals who hiccup, it has no value but does provide another bit of evidence of our common ancestry.”<sup>5</sup>

## Definition of hiccups

A hiccup, or hiccough, medical term *singultus* or *synchronous diaphragmatic flutter* (SDF), is a largely involuntary contraction (a myoclonic jerk) of the diaphragm that repeats some 4 to 60 times per minute. It involves a reflex arc that, once triggered, causes a strong contraction of the diaphragm followed by closure of the vocal cords, which results in the classic ‘hic’ sound.

One evolutionary explanation of why mammals still have this reflex is “because it has permitted the development of pattern generators for other useful functions of the pharynx and



**Figure 1.** Diaphragm showing contraction which can spasm, causing hiccups.

chest wall muscles, such as suckling or eupneic breathing”.<sup>6</sup>

### Problems with the claimed evolutionary origin of hiccups

Evolutionary biologist Sandeep Venkataram admitted about the just-so hiccup causation theories outlined above, “as always, ‘evolutionary purpose’ questions require answers that [are] essentially pure speculation, as there is no way we can gather data to figure out what selective pressures, if any were present when this reflex evolved.”<sup>7</sup> Besides this major problem, scientists do not fully understand the various functions of hiccups, but there are several viable proposals, with good evidence for one important function. Furthermore, hiccups in humans are caused by the very complex system noted by Mosley above that is drastically different from, and far more complex than, that existing in fish. This complexity in and of itself strongly suggests that they have an important function and are not mere remnants of our postulated evolution from fish.

### Their purpose in humans

Fetal (intrauterine) hiccups are of two types. One type occurs prior to 28 weeks after conception, and the hiccup lasts as long as five to 10 minutes. These fetal development hiccups are associated with the development of myelination in the phrenic nerve, which controls the thoracic diaphragm.<sup>8</sup>

The best explanation for the function of hiccups following birth is based on the fact that hiccups are found only in mammals, all of which drink milk as infants. In humans, hiccups are far more common in infants; newborn infants spend 2.5% of their time hiccupping, which becomes less frequent as the child ages.<sup>9</sup>

This observation is consistent with the notion that hiccups were designed to allow air trapped in the stomach of suckling infants to escape, allowing more milk to be ingested. Hiccups, along with other reflexes such as the swallowing reflex, allow infant mammals, including humans, to coordinate suckling milk and breathing. In humans, the air bubble in the stomach stimulates the sensory receptors in the

stomach, esophagus, and along the diaphragm. This reflexively triggers the hiccup, which creates suction in the chest, pulling air from the stomach up and out through the mouth, effectively burping the animal or human.

This theory is supported by the strong tendency for infants to exhibit hiccups, and by the fact that one component of the hiccup reflex suppresses peristalsis (the normal propulsive movement) in the esophagus, and by the existence of hiccups only in milk-drinking mammals. In humans this process is called burping, which is often helped by patting the child on his or her back.

In view of its complexity, Howes concludes: “Rather than continuing as a vestigial reflex whose purpose has evolved away” the hiccup system is a “surprisingly complex reflex to remove air from the stomachs of young suckling mammals.”<sup>10</sup> He concludes that hiccups are triggered in the very young by excess air in the stomach. This excess air stimulates the hiccup reflex, which forces “swallowed air out of the stomach ... [thereby] effectively ‘burping’ suckling infants, allowing them to consume a greater volume of milk in the meal.”<sup>11</sup>

For this system to function, the stomach must be able to differentiate air from liquids. Furthermore, such a ‘burping reflex’ is no minor response, but important because

“Young mammals depend on milk consumption for their nutrition. The continuous nature of suckling means that it has to be coordinated with respiration and the result can be swallowed air. A reflex that helps remove swallowed air would significantly increase the stomach’s capacity for milk.”<sup>12</sup>

The hiccup has been shown experimentally to cause a sharp drop in the intrathoracic pressure. The negative intrathoracic pressure moves material from the stomach toward the mid-section of the esophagus. The contents of the stomach include the materials from



digestion, and gas. The vomiting reflex is effective in removing any unwanted materials that result from digestion, leaving the removal of stomach gas as the likely reason for physiologic hiccups.<sup>13</sup>

Many so-called cures for hiccups appear to deal with the excess gas in the stomach. The common remedy of swallowing granulated sugar is claimed to absorb the excess gas,<sup>14</sup> though a more common theory is that the roughness of the granules in the pharynx stimulates the vagus nerve to break the hiccup cycle.

### Hiccups—likely part of a ‘burping reflex’

It seems likely then that hiccups are a ‘burping reflex’ particularly important in suckling infants. It is triggered by the brain’s hiccup centre sending signals along efferent nerves to the diaphragm, the external intercostal muscles, the scalene muscles, the glottic structures, and the esophagus. The end result is to force excess air out of the infant’s stomach. The most important muscle involved in this reflex is the diaphragm, and the hiccup response is usually unilateral, often involving only the left half of the diaphragm.<sup>15</sup> This supports the theory proposed here, since it is primarily the left side that forces excess air out of the infant’s stomach.

### Hiccups can signal pathology

Hiccups may occur individually or in bouts. The hiccup rhythm, or the time between hiccups, tends to be relatively constant. More often, they go unnoticed or are considered a minor annoyance that serves no valuable purpose.<sup>16</sup> Bouts of hiccups usually resolve without intervention, although home remedies are often used to shorten their duration. Medical treatment is occasionally necessary in cases of chronic hiccups or those that continue

for over 48 hours or occur abnormally frequently.

They can also be clinical indicators of serious disease, including infection or malignancy near the diaphragm, lesions or diseases of the brain and other parts of the nervous system, as well as pancreatic and other cancers.<sup>17,18</sup> Kidney failure leading to toxic waste products built up inside the body can cause both diaphragm discomfort and hiccups.

Hiccups can also be triggered by events that produce excess gas in the stomach, a further pointer to their function. These include overeating or eating in such a way as to cause the swallowing of abnormal amounts of air, overindulgence of alcohol, or drinking carbonated beverages.<sup>19</sup>

### Summary

The evolutionary claims about why humans have hiccups are just-so stories which, when examined, are problematic, as is the claim that hiccups do not have a function. At least one function is strongly suggested by the evidence: hiccups exist along with other reflexes that were designed to enable mammals to coordinate suckling milk and breathing, by forcing out excess stomach gas, thereby ‘burping’ the infant. Hiccups are also very useful indicators of pathology and problematic habits that lead to excess stomach gas and/or gastric distention.

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# What is the origin of carbonates in sedimentary rocks?

Michael J. Oard

Carbonate rocks are defined as rocks that contain more than 50% carbonate by weight. They are mainly limestone and dolomite.<sup>1</sup> Carbonates are considered chemical sedimentary rocks formed out of solution through various chemical processes. Most carbonates were deposited by physical processes such as debris flows during the Flood. These are mostly the fine-grained or mud deposits. Some form from the skeletons of microorganisms. Limestone,  $\text{CaCO}_3$ , is composed mainly of calcite or aragonite, different polymorphs of  $\text{CaCO}_3$  with a different atomic arrangement. Dolomite is calcium and magnesium carbonate,  $\text{CaMg}(\text{CO}_3)_2$ . The rock is called dolostone, but geologists

often refer to dolostone as dolomite. To be considered a dolostone, 50% of the carbonate must be the mineral dolomite. If the calcite has less, but a still appreciable amount of, Mg, it is considered a high Mg calcite.

Although estimates have varied, carbonates make up 20–25% of all sedimentary rocks.<sup>2</sup> Carbonates are quite variable and are often layered with or interbedded with other types of sedimentary rocks. They also form one of the main types of cement for sedimentary rocks. Carbonates are found as low as the Archean, but they are most abundant in the late Proterozoic and early Paleozoic rocks.<sup>3</sup> Much carbonate is also found in the Cenozoic.<sup>4</sup>

## Huge thickness of inorganic carbonate precipitation challenges uniformitarians

Uniformitarian scientists have attempted to claim that many carbonates represent the accumulation of carbonate from organisms. However, they do have trouble explaining the carbonates that were deposited out of fluid solution or from mass flows of

carbonate mud, especially those in the Precambrian that have abundant carbonates. Some of these fine-grained carbonates (micrite) are up to about 5,000 m thick.<sup>5</sup> Boggs states:

“The most controversial carbonate deposits, however, are the huge volumes of nonfossiliferous carbonate mud (micrites) present in both the Precambrian and Phanerozoic stratigraphic record. ... We have a more difficult time explaining the formation of Precambrian limestones ... that, as far as we know, were deposited before the widespread appearance of calcium-secreting organisms.”<sup>6</sup>

## The dolomite problem

Dolomite can also be widespread and thick. It is more common in Precambrian rocks. Dolomite is sometimes associated with the so-called ‘evaporites’, particularly anhydrite or gypsum. Anhydrite is the same as gypsum but without water. It is known that dolomite has replaced limestone by the addition of magnesium ions in fluids moving through the limestone. It is also known that some dolomite was deposited directly as *primary* dolomite. However, the origin of primary dolomite is an unsolved problem for uniformitarianism:

“Dolomites have been studied very extensively; therefore, in theory, we ought to understand their origin quite well. On the contrary, the origin of dolomites remains one of the most thoroughly researched but poorly understood problems in sedimentary geology. ... It is these fine-crystalline dolomites that have created the so-called *dolomite problem*, which geologists have not been able to satisfactorily solve ... Elevated temperatures, exceeding 60°C, are required to produce stoichiometric dolomite in the laboratory ... [emphasis in original].”<sup>7</sup>



Image: Eurico Zimbres Zimbres/CC-BY-SA 3.0

Figure 1. Carbonatite from Brazil that also contains magnetite and olivine



Such dolomite defies the uniformitarian principle in that no primary dolomite of significance is being deposited today:

“Where is dolomite being deposited today? Nowhere does dolomite seem to be forming on a large scale . . . . However, in recent years dolomite had been found, albeit in rather small volume, in a number of somewhat restricted environments.”<sup>8</sup>

Some have suggested that microorganisms help precipitation dolomite,<sup>9</sup> but this is still under debate.<sup>10</sup>

### Challenge also for creation scientists

The volume of carbonates and the origin of primary dolomite also present a challenge for creation scientists to explain. First, we need to establish whether the carbonates, especially the abundant Precambrian carbonates, are from the Flood or pre-Flood. I have argued that they were very likely deposited during the Flood.<sup>11</sup> For instance, microorganisms and raindrop imprints are found in Precambrian sedimentary rocks. Moreover, several rock types abundant in Precambrian sedimentary rocks are also found into the Paleozoic, as if there were no discontinuity at the Precambrian/Paleozoic contact. These include high organic black shales, quartz arenites (sandstones with greater than 95% quartz with generally rounded frost grains), and carbonate rocks.

Assuming the Precambrian sedimentary rocks are very early Flood rocks,<sup>12</sup> where would such a large volume of carbonate originate? One possibility is that the carbonates boiled up from the ‘fountains of the great deep’ either as carbonate dissolved in water or as an igneous rock. Another possibility is that on Day 3 God made great carbonate banks or continental shelves, which would have been a source of carbonate early in the Flood. A hint as to the possibility of the former is that some igneous intrusions in the past have released lava that is greater than

or equal to 50% carbonate.<sup>13</sup> These are called ‘carbonatites’ (figure 1).<sup>1</sup> The other 50% of the lava has been found to have minerals composed of sodium, potassium, calcium, etc., and have been given such names as ‘natrocarbonatite’, a high sodium carbonatite, and ‘Ca-carbonatite’ which has high amounts of calcium. Carbonatites have a low viscosity like basalt lava.

Carbonatites are often thought of as very rare, since only one volcano has been observed erupting carbonatites today, Oldoinyo Lengai, in Tanzania.<sup>13,14</sup> However, this is not necessarily true for the past, with 500 fossil, non-erupting Ca-carbonatite volcanos discovered so far.<sup>15</sup> They are predominantly found in Africa. So, they must have been more common in the past, such as during the Genesis Flood.

The existence of carbonatites suggests they may have first been fluids and melts in the mantle:

“Our study suggests that alkali carbonate fluids and melts could have commonly formed in the geological past . . . . Thus, alkali carbonate fluids and melts have been so far overlooked in the geological record because of the lack of previously detailed inclusion studies.”<sup>16</sup>

The existence of past carbonatite eruptions suggests that carbonates very likely originated in the mantle or lower crust. This suggests abundant carbonates erupted early in the Flood from below the ground and were associated with the widespread volcanism in the ‘fountains of the great deep’. This can possibly account for the abundant Proterozoic and Paleozoic carbonates. The heat of these eruptions may also have been responsible for the deposition of primary dolomite, which is found especially in Proterozoic and Paleozoic sedimentary rocks.

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# Finally, a book on sex from a creation worldview

## ***Darwin's Secret Sex Problem: Exposing evolution's fatal flaw—the origin of sex***

F. LaGard Smith

WestBow Press, Bloomington, IN, 2018

Jerry Bergman

This is the only book I am aware of that covers in detail the widely acknowledged problem of the evolutionary origin of sexual reproduction, often abbreviated as sex. Professor F. LaGard Smith has spent most of his career as a Professor of Law, principally at Pepperdine University School of Law, but is also the author of over 30 books on a wide variety of legal, social, and religious topics. He is most widely known as the compiler and narrator of the best-selling *The Daily Bible*.®

In this book, Smith successfully answers Darwin's famous challenge: "If it could be demonstrated that any complex organ existed, which could not possibly have been formed by numerous, successive, slight modifications, my theory would absolutely break down. But I can find no such case."<sup>1</sup> Smith concluded that sexual reproduction does not involve one organ, but numerous organs that all work harmoniously together to produce the entire complex reproductive system. His main theme in his book is called "the half-of-a-wing problem", i.e. a half of a bird wing is worse than useless because it greatly interferes with land travel of the organism and wastes nutrients (pp. 48–50).

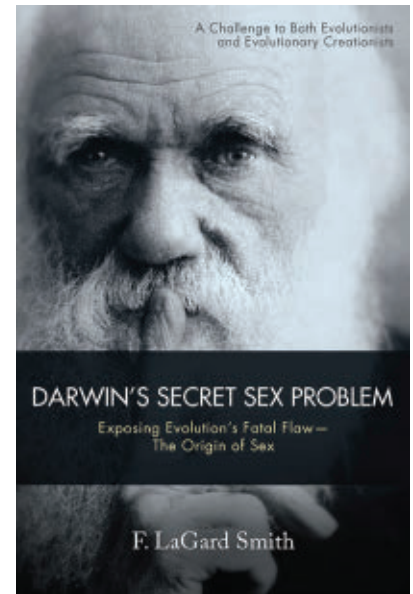
The evolutionary theory postulates that asexual reproduction eventually, after many millions of years, evolved

into sexual reproduction. Smith contrasts the two main forms of reproduction, documenting the enormous gap between them that cannot be bridged by evolution. Evolutionists recognize the problem of the origin of sex and this is why it is called the "queen of evolutionary problems" (p. xxix). As Richard Dawkins asked, "why did sex, that bizarre perversion of straightforward replication, ever arise in the first place? This is an extremely difficult question for evolutionists to answer ... I am frankly going to evade it" (p. xxx).<sup>2</sup>

Much of the book focuses on refuting Darwin's *Grand Theory* that teaches evolution from the sea to the land, and from amphibians to reptiles, by addressing the chasm between the reproduction systems. Smith shows the "queen of evolutionary problems" alone refutes Darwin's *Grand Theory* (p. 54).

A major sexual gap is evolution from sexual reproduction by external fertilization to internal fertilization. External fertilization involves male sperm fertilizing a female-produced egg *outside* of the female's body. This typically occurs in water or moist areas to facilitate the movement of the male sperm to fertilize the female egg. In water, males and females must release gametes at similar times and locations to fertilize the egg, a problem reduced by females building nests in which to lay her eggs, and then males are programmed to deposit their sperm into the nests (p. 53).

Internal fertilization involves sperm being introduced via insemination to soon combine with an egg *inside* the female's body. The evolutionary theory proposes that when life moved from the sea to the land, this transition forced the evolution of internal



fertilization from the previous external fertilization system. This change results in a major evolutionary gap between two very different systems, a gap which has not been bridged in the last 150 years, not even with plausible just-so stories (p. 53).

Although most fish species spawn eggs that are fertilized externally, typically with the female laying the eggs and the male inseminating them, the exceptions are the cartilaginous fish (sharks, skates, rays, chimaeras). In this case, the eggs are fertilized internally, although cartilaginous fish exhibit a wide variety of both internal and external embryonic development. Thus, the most logical water-to-land evolution would be from some cartilaginous fish to reptiles, an evolutionary route largely rejected because of the enormous differences between cartilaginous fish and reptiles. The most widely accepted evolutionary path from external to internal fertilization is from bony fish to amphibians to reptiles. Smith shows this path is also separated by a chasm.

## **Amniotic evolution**

Also required for internal fertilization to evolve is the amniotic system which evolutionists claim evolved



from the amphibian reproductive system. The amniotic egg is the system produced by reptiles, birds, and prototherian (egg-laying) mammals (p. 54). The amniotic egg enabled animals to live on dry land without the requirement to return to water for reproduction as required by amphibians. This type of reproductive system “is vastly more complex and utterly different to that of an amphibian” (pp. 54–56).<sup>3</sup>

In this system the embryo develops inside an amnion sac filled with amniotic fluid which, in turn, is connected to the placenta. The placenta is an enormously complex system that interfaces between the mother and the child. It provides oxygen and nutrients to the fetus, while removing carbon dioxide, urine, and numerous other waste products. It also metabolizes a wide variety of substances and releases numerous metabolic products into the maternal and/or fetal circulations.

Smith shows the evolution from a non-amniotic egg to an amniotic system has never been documented in the fossil record. The reason is not only because soft tissue fossilizes poorly. A more important reason is that it faces the same problem he documents throughout the book, namely a new system will not allow survival until the hundreds of required changes are complete to the degree required for the new system to function properly.

The new sexual reproductive system involves not just compatible copulatory organs evolving simultaneously in both the male and female. It also needs an effective system that supports the embryo while it is developing, and allows for its birth, feeding, and caring for it until it is ready to live on its own. For amphibians to evolve into reptiles, as evolution postulates, all of these changes must have first developed in water to allow the new organism to function. It would not have been able to move to dry land until it was fully developed and reasonably effective (pp. 54–55).

Another evolutionary problem is the harmony of estrus cycles, or the

narrow windows of time when animals are able to mate, called being “in heat”. These vary greatly as to season, length, and how many times annually the sexual readiness occurs. Humans are the only species that are sexually active all year round but, although most animals are monestrous, some are diestrous, and a few are polyestrous (pp. 61–62). The male and female must be on the same mating cycle for mating to occur (figure 1).

Another chasm between asexual and sexual life is sexual dimorphism where the sexes physically vary, allowing animals to effectively differentiate the males from the females of their species by external physical traits. Their behaviour must also fit their sexual role. Females usually nurture, protect, and rear their offspring. Males must also often support, protect, and defend their mate and offspring.

Even here many different patterns exist. The only known example where the birthing role is reversed is in seahorses. In this case, males both birth and nurture the offspring. Note the critical factor is that both the male-female physical and social roles must be compatible. Usually the female nurtures the young, but in a small number of cases her mate does, or the young are born not needing parental support and can live on their own very soon after birth, such as is true of sea turtles.

Another topic covered is that design generally limits sexual reproduction of a species to members of the same species. For example, all known chimp and human interbreeding attempts have failed.<sup>4</sup> In most cases, we do not know why cross-fertilization does not work, partly because geneticists have not done the research. One case we do know is the multi-million-dollar industry of dog breeding. Dog sperm looks similar to human sperm, but unlike the human version, dog sperm has a thick cholesterol complex that covers the sperm head where the DNA is located. When sperm travels through a female dog’s uterus, chemicals, including

magnesium, effectively break down that coating.

If the coating remains intact, the sperm’s DNA can’t fertilize the egg, which would be true in all animals that cannot break down the cholesterol complex barrier. Furthermore, the same batch of chemicals also causes the sperm to wiggle its tail, which functions like a propeller to cause it to swim faster, and help it burrow into the egg to deposit its DNA in it. In some cases foreign sperm cannot penetrate the egg for similar reasons. In short, a complex set of interactions are normally required for sperm to penetrate the various egg barriers and fertilize the egg.

### Mitosis evolves into meiosis

Sexual reproduction requires meiosis which produces haploid cells that contain half the normal number of chromosomes, which is 23 in humans. Evolutionists propose that after eons mutations in the genes evolved mitosis into meiosis. Chapter 5 (pp. 71–89) covers this problem in detail, explaining the difference, why it exists, and the fact that the evolution of meiosis from mitosis is untenable based on the half-of-a-wing problem. In short, mitosis is a copy machine but, in contrast, meiosis is a functional creator that produces the potential for the enormous variety seen everywhere in most forms of life today (p. 94).

Furthermore, evolutionists almost uniformly ignore the problem, unlike Zimmer and Emlen who admitted in their popular textbook the following: “Given the functional uniqueness of sexual reproduction at even the most primitive level, what we will see over and over throughout this book is that such an assumed gradual process could not, in actual scientific fact, have happened” (p. 81).<sup>5</sup>

But, according to evolutionists, it *must* have happened. Smith also quotes Dawkins who stated these replicators are required, writing, “sexual reproduction is a prime example of a complex adaption for which a large number

of replicator substitutions would be required” (p. 81).<sup>6</sup> Furthermore, not just meiosis but transposition, imprinting, epigenetics, genetic crossing over, the topoisomerase mechanism, and numerous other complex systems must evolve, none of which have been explained by evolution, even by just-so stories.

### The problem of gender evolution

Gender was also covered; the fact that males and females are more than mechanical plumbing differences, but also result from numerous body, hormonal, and personality differences. Smith quotes several biologists, such as Professor Graham Bell, who documents that every

“... student knows that homologous chromosomes usually segregate randomly during the division of the nucleus; no professor knows why. Every layman knows that all the familiar animals and plants have two sexes, but never more; few scientists have thought to ask, and none have succeeded in understanding, why there should not often be three or many sexes, as there are in some ciliates and fungi (p. 114).”<sup>7</sup>

This view of gender as taught in Genesis, “God created them male and female”, has now been challenged by the so-called progressive culture that argues as many as 112 genders exist besides male and female, including bisexual, asexual, homosexual, transsexual (a male body and a female gender, or female body and male gender), and questioners, the condition that exists when one is not sure of one’s gender.<sup>8</sup>

In contrast to the gender dysphoria advocated by the progressives, the long parts list required for sexual reproduction to function includes both the sex organs on the outside of the body as well as those inside of the body. Furthermore, body parts are only half the story. What is required is male and female behaviour, not just compatible gonads (p. xxii). Sexual reproduction must be successful in the first generation for there to be another generation, although once this mode of reproduction is successful it can, in theory, be fine-tuned during further generations (p. xxvii). In short, “no generation can pass on any slightly evolutionary advantages to a generation that can’t yet” reproduce (p. 22).

Furthermore, a question Smith poses is, “Why are there usually two genders throughout the plant and animal kingdom?” (p. 28), and only two genders in mammals, but it gets more complex in insects, such as bees which have three ‘genders’, the drone, worker, and queen (pp. 99, 164). Other animals can be sexual and also parthenogenetic (a form of asexual reproduction in which growth and development of embryos occur without fertilization by a male gamete) at the same time, like earthworms, aphids, hydras, and sponges (pp. 99–100, 118). Some life-forms, like yeast, can reproduce asexually by budding or fission, or can form haploid spores that eventually fuse with other spores to form a diploid zygote just as occurs with sexual reproduction (p. 100). These quirks only complicate the evolution claims, and do not add to, or support, our understanding of the evolution of sex (pp. 100–102).

Also covered is the enormous variety of insect sexual organs, some so distinct that they are not homologous with any other known organ in the insect world. Their evolution appears to be a complete mystery (pp. 56–67). These examples illustrate the maxim that a sexual system is worse than useless until it has developed to the point where it effectively functions. Part 4 of Smith covers the futility of “comingling evolution and creation”, specifically as attempted by those organizations, such as BioLogos, and those who advocate creation by evolution (pp. 201–300). This excellent section deserves a long, detailed separate review which is not possible here.

### Conclusions

In conclusion, this work effectively documents the fact that the evolution of sexual reproduction is a major unsolved, and unsolvable, problem for evolution. The Smith book is well written, easy to follow, frequently adding some humour to break up the sometimes rather technical discussions. It covers many concepts which are



Image: ToastyKen/CC BY 3.0 [edited]

**Figure 1.** A picture of a male peacock with its tail in full display, and the female, called a peahen, which lacks the resplendent tail. An evolutionary problem is the narrow windows of time when animals are able to mate. Both male and female must be on the same mating cycle for mating to occur.



explained quite well, often in layman's terms, so that the book is accessible to most high school graduates who have had high school biology and chemistry. The book contains a glossary (pp. 301–306) an index (pp. 307–313), and a list of references (pp. 315–325). One complaint is that much of the book used endnotes instead of footnotes which are much easier to use to check claims made by the author. In my review, I provided complete references to those sources I quoted in Smith.

The conclusion of the theme of Smith's book, by the former editor of *Nature*, as to when and how sexual reproduction evolved, "Despite decades of speculation, we do not know" (p. 102).<sup>9</sup> As Smith quoted, the classic study of the origin of sex concluded, "how or why sex [evolved] is a deep mystery" (p. 65).<sup>10</sup>

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# How the universe made itself with entropy

*Until the End of Time: Mind, matter and our search for meaning in an evolving universe*

Brian Greene

Penguin Random House, New York, 2020

Alex Williams

From the day of its release (February 18), Brian Greene's latest book became an "instant *New York Times* bestseller" with the review on *Amazon.com* describing it as "a breathtaking new exploration of the cosmos and our quest to find meaning in the face of this vast expanse",<sup>1</sup> Greene is a multi-award-winning theoretical physicist, author of several best-selling popular science books, widely known from TV and movie appearances, and founder of the annual *World Science Festival*.<sup>2</sup>

In the preface, he heralds his storyline as follows:

"... we will walk the timeline of the universe, exploring the physical principles that yield orderly structures from stars and galaxies to life and consciousness, within a universe destined for decay. ... We emerge from laws that, as far as we can tell, are timeless, and yet we exist for the briefest moment of time. We are guided by laws that operate without concern for destination, and yet we constantly ask ourselves where we are headed. We are shaped by laws that seem not to require an underlying rationale, and yet we persistently seek meaning and purpose. ... It is a journey powered by science, given significance by humanity ..." (pp. xii–xiii; all page numbers refer to Kindle edition).



It is an exemplary piece of science writing and likely to be a prize winner. However, Greene is to cosmology something like what Richard Dawkins is to biology—an articulate and persuasive storyteller who peddles a biased selection of scientific information cobbled together with logically flawed arguments to try to explain the universe without reference to a creator. And, like Dawkins, he fails spectacularly.

## Reductionistic scientism

Greene persuades his audience that "everything from the big bang to Beethoven's Ninth Symphony" can be explained in terms of particles moving according to the laws of physics:

"You are a swarm of interacting particles. So am I. ... While I understand how your particles can cause you to smile or frown—again, *the particles* just need to appropriately *choreograph* their motions—I am at a loss to understand how the particles yield an inner sensation

of happiness or sadness [emphases added]” (p. 125).

He is not using a metaphor here—he is deadly serious, believing implicitly that what he says is factually accurate. He attributes *agency* to the particles, but not to the *person*! He goes on pushing the concept to absurd lengths:

“Imagine that you and a rock, each minding your own business, are idly sitting next to each other on a park bench. As I walk by, you suddenly see that a hefty tree limb has snapped and is hurtling toward me. You leap from the bench and tackle me with great force, thrusting us both out of harm’s way. What is the explanation for your heroic, life-saving act? All the particles making up you and all of those making up the rock are subject to the very same laws, and so neither you nor the rock has free will. Yet it is you who jumped from the bench while the rock just sat there. How do we explain this?

You saved me but the rock didn’t because your particles are so spectacularly ordered, so breathtakingly configured, that *they* can undertake exquisitely choreographed motions that are not possible for the particles constituting the rock [emphasis added]” (p. 151).<sup>3</sup>

Notice again that the particles are the active agents! At that point he adds a footnote saying that the difference between the person and the rock is just a matter of probability (p. 353, f.n. 42).

Has the world gone so mad that such jaw-dropping insanity can be promoted as award-winning science writing? It seems so. Countless eminent scientists around the world have become so used to swallowing and regurgitating Darwinian myths that they have lost the ability to think rationally! In fact, under his theory, ‘thinking’ is just the motion of atoms. And he couldn’t help what he wrote!

Greene’s book is the clearest expression I have ever encountered of *reductionistic scientism*.

*Reductionism* is the belief that everything can be understood by examining its parts. For example, reductionism says that you can understand a steam engine (Greene’s example) by taking it apart and studying how each of the parts contribute to the working of the whole. Such an argument sounds reasonable—until you push it further in order to explain how the parts themselves were assembled from their constituent particles into the sizes, shapes, and relative positions that allow the steam engine to function. Unsurprisingly, reductionism is silent on the subject—it has no explanatory power at all!

*Scientism*, on the other hand, is the belief that science can, in principle (if not yet in fact), explain everything. It is atheistic, materialistic, and naturalistic. It is self-refuting: there is no scientific experiment that can show that science can explain everything. It is also deeply deceptive because it trades on the astounding success of science in giving us sophisticated material goods and luxurious living standards to then argue that it can therefore do *anything* and *everything* else! However, the enduring mysteries of the origin of the universe, the origin of life, and the origin of human consciousness—all of which Greene concedes—stand as witnesses that science is not all-powerful. Indeed, human consciousness is axiomatic to the whole scientific enterprise, a point of logic that is lethal to Greene’s argument, but he seems to be unaware of it.

But he is not so foolish as to think that there are no gaps in reductionist explanations. To bridge these gaps, he invokes the help of just two apparently all-powerful ‘magic’ ingredients—*entropy* and *evolution*. Choosing only two such explanatory principles makes things easier for the general reader because it appears to provide clearer insight into the often-complex material that he addresses. But for the critically informed reader, it also allows us to see in the starkest possible detail both the foolishness and the culpability of his enterprise.

## The entropic two-step

Greene introduces entropy with the classic story of the steam engine and the development of the laws of thermodynamics. He shows that while entropy (roughly equivalent to our common notion of disorder) within a closed system must always increase, there are exceptional times and places where a local decrease of entropy ‘just here’ is allowed because a greater increase is produced ‘over there’ and so the requirement for continual increase in the system as a whole is maintained. In the case of the steam engine the decrease ‘just here’ is the ordered structure and function of the passenger train, while the greater increase ‘over there’ is the release of waste heat into the environment (figure 1). He calls this principle ‘the entropic two-step’. It consists of one creative step backwards, in which ordered structures are produced, then two steps forward as (a) energy flows through the ordered structures and (b) waste heat is released into the environment, ensuring the increase of entropy in the overall system.

He then generalizes the principle to everything in the universe:

“The entropic two-step lies at the heart of how a universe heading toward ever-greater disorder can nevertheless yield and support ordered structures like stars, planets, and people. A theme we will encounter repeatedly is that when energy flows through a system—like the energy from burning coal flowing through the steam, driving work, and then exiting to the surrounding environment—it carries away entropy and can thus sustain or even produce order in its wake. It is this entropic dance that will choreograph the rise of life and mind, as well as most everything that minds deem to matter” (pp. 41–42).

Notice that, taking the steam engine as his teaching example, he summarises his principle of the entropic two-step without any reference at all to the actual steam engine. The intelligently designed, constructed, and

operated steam engine is at the heart of his teaching example, so Greene has to use an intellectual ‘sleight-of-hand’ manoeuvre to whisk away the entropic two-step principle while leaving behind its functional heart (the steam engine) as if it is somehow irrelevant.

And this is how Greene goes on to explain everything—by ignoring the ‘system’ (e.g. galaxies, stars, planets, people, steam engines) and just focusing on the entropic energy flows. It reminded me of the way that Richard Dawkins in *The Selfish Gene* fooled the world into thinking that organisms were unimportant, and genes were the key to explaining life on Earth.<sup>4</sup>

### Evolution

Greene does a similar kind of intellectual sleight-of-hand manoeuvre with evolution. He tells us that Darwinian evolution (via natural selection) can explain everything about life, even its origin from chemicals (which he does admit is speculative at present). But as anyone can work out for themselves, natural selection only selects among a variety of organisms that already exist, so it provides no explanation at all for where those organisms or their variations came from. Yet in the mind of Darwinists, natural selection is the creative agency in evolution, and it

explains everything about life on Earth. And because they have nothing else to appeal to, they must also invoke natural selection as the creative agency which explains the origin of life from ‘dead’ environmental chemicals. However, they overlook the fact that natural selection means differential reproduction, so cannot exist before there are self-reproducing entities.

### Imaginative storytelling

Greene is such an erudite storyteller that almost everything he says sounds either convincing or persuasive. But, as I have shown so far, his two explanatory principles—entropy and evolution—are wholly inadequate for the task, so I will illustrate with a few examples.

Historically, inflation theory was introduced to fix problems in earlier formulations of big bang theory. It was originally proposed to have occurred during some tiny fractions of a second *after* the big bang, and it supposedly inflated the primordial singularity up to something like a sub-human scale. However, in Greene’s modern version of the story it is now inflation that *triggers* the big bang, and the inflation event itself was bigger than the currently observable universe! Yet his version of inflation still also occurs *after* the big bang, so he gets to eat his cake and still have it (p. 48).

How did this universe-sized inflation event occur? Greene appeals entirely to chance saying that “if you wait long enough even the most unlikely of things will happen” and he claims that this is a “simple observation” (p. 54). But according to what he has told us that scientists have actually observed about entropy, if you wait long enough then entropy becomes maxed-out

and nothing at all happens! So once again he chooses to eat his cake and have it too.

Yet he then admits:

“This is not the only proposal for how inflationary expansion may have gotten off the ground. Andrei Linde, one of inflationary cosmology’s pioneers, has quipped that ‘for every three researchers there are at least nine opinions on the matter.’ So we must leave to future research, ... a more definitive answer ... For now, we will simply assume that one way or another, the early universe transitioned into this low-entropy, highly ordered configuration, sparking the bang and allowing us to declare that the rest is history” (p. 55).

So, by his own admission, he is telling us nothing at all about the origin of the universe!

When it comes to large-scale structure in the universe (galaxies, stars, planets) Greene appeals to ‘gravitational snowballing’ as the universal cause. For those unfamiliar with snowball-making you begin with two handfuls of snow and compact them together to make a solid core. You then place this core on a patch of snowy ground and start rolling it along (or down a hill, which is much more fun). As it rolls along, newly encountered snow sticks to the already-compressed snow and the whole thing quickly grows into a large scroll. Good fun, but a culpably deceptive metaphor!

The early big bang universe consisted *only* of high-velocity gas molecules (mainly hydrogen and helium) expanding rapidly along with expanding spacetime. Neither the physics nor the mathematics of this era is anything like snowball-making. Snowballs stick together via electrostatic forces, and they stay on the ground because the earth is large enough for the mutual gravitational attraction to hold the two together. But the kinetic energy of gas molecules far, far exceeds any electrostatic forces, and it is much, much greater than any mutual gravitational attraction. There is nothing in the early



**Figure 1.** Greene uses the steam engine to explain the formulation of the laws of thermodynamics and the concept of entropy on p. 17 in Chapter 2 of *The Language of Time*. However, he then falsely argues that entropy is the creative agent in the formation of material structure throughout the universe.



big bang universe to cause stars to form so physicists just use their imagination—that is all it is!

Furthermore, according to modern nucleosynthesis theory, higher elements (e.g. those that make up rocky planets like Earth) were created in the cores of exploding stars (supernovae) and blasted into space. However, this ‘stardust’ consists of very tiny refractory grains of things like silicate minerals and metal oxides that are very chemically stable. So, they provide no mutual electrostatic attraction to each other, and they are also way too small to be subject to mutual gravitational attraction. Gravity does not begin to have any influence over such tiny grains until at least some of them grow (by unknown means) to the size of large asteroids! Many recent astronomical images purport to show star formation in regions where giant molecular clouds collide, but this is not “gravitational snowballing” of stars forming stepwise out of stardust. Rather, it would be more akin to avalanche meets avalanche.

When it comes to life, Greene refuses to believe that there are any irreducible barriers to reductionism’s explanatory power. Rather, what might appear to be irreducible barriers are simply written off as different ways that scientists in different disciplines choose to tell their stories:

“There are many ways of understanding the world. In the traditional organization of the sciences, physics deals with elementary particles and their various unions, chemistry with atoms and molecules, and biology with life. ... In more recent times, however, the deeper researchers have probed, the more they’ve realized that grasping the crossovers between disciplines is essential. The sciences are not separate. ... Even the staunch reductionist realizes that as fatuous as it would be to explain a baseball’s trajectory in terms of molecular motion, it would only be more so to invoke such a microscopic perspective in explaining what a batter was feeling as the pitcher went through his windup, the crowd

roared, and the fastball approached. Instead, higher-level stories told in the language of human reflection provide far greater insight. Nevertheless—and this is key—these better-suited human-level stories must be compatible with the reductionist account. We are physical creatures subject to physical law. ... A refined understanding is gleaned by integrating each discipline’s story into a finely textured narrative” (pp. 71–72).

In other words, all you need to do, according to Greene, is to be a good storyteller—as he is—and all the barriers to reductionism will fall into line behind you and take upon themselves the appearance of being consistent with reductionist philosophy.

In a footnote at this point, he describes his personal philosophy as follows:

“... were I to label my own view, the one that will guide our discussion across this book, I would call it ‘nested naturalism’. Nested naturalism ... is committed to the value and the universal applicability of reductionism. It takes as a given that there is a fundamental unity in the workings of the world, and posits that such unity will be found by pursuing the reductionist program to whatever depth it leads. Everything that takes place in the world admits a description in terms of nature’s fundamental constituents following the dictates of nature’s fundamental laws. Nested naturalism also emphasizes, though, that such a description has limited explanatory power. There are many other levels of understanding that wrap around the reductionist account much as the outer parts of a nest wrap around its innermost structure. And depending on the questions being pursued, these other explanatory stories can provide accounts that are far more insightful than the one provided by reductionism. All of the accounts must be mutually consistent, but new and useful concepts can emerge at higher levels that do not admit lower-level correlates. ...

nested naturalism freely invokes accounts at whatever levels of structure prove most illuminating, all the while ensuring that the accounts fit into a coherent description” (pp. 341–342, f.n. 8).

So, all the barriers to reductionist explanations can be compared to layers that surround the centre of a nest. Where do these ‘layers’ come from? Obviously, from the entropic two-step playing out on the cosmological stage:

“... living things share a deep kinship not just with one another but with stars and steam engines too: life is one more means the universe employs to release the entropy potential locked within matter” (p. 72).

So, everything can be explained and understood as arising from “the entropy potential locked within matter.” And if, perchance, “new and useful concepts emerge at higher levels that do not admit lower-level correlates [i.e. they cannot be explained by reductionism]” then “nested naturalism” will “ensure that the accounts fit into a coherent description.” In other words, heads I win, tails you lose. To an evolutionist, all evidence supports evolution (even if it doesn’t), and to a materialist, all evidence supports materialism (even if it doesn’t), and to a reductionist, all evidence supports reductionism (even if it doesn’t). All you have to do is to tell the story in the right way—this is Greene’s message to the world, and he doesn’t seem to be ashamed of it.

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# God vs science?

## ***Let There Be Science: Why God loves science, and science needs God***

David Hutchings and Tom McLeish  
Lion Books, Oxford, UK, 2017

Lucien Tuinstra

It is commonplace in our day and culture to think of science and God as in conflict. Either they have nothing to do with each other, or they positively disagree with each other. But are they really at odds? *Let there be Science* is a 206-page response to this. It attempts to show, as the subtitle of the book says, “Why God loves science, and science needs God”.

The authors, David Hutchings and Tom McLeish, are well qualified to comment. Hutchings has a First Class Honours in Physics with Business Management followed by a PGCE with a major in Science, each from the University of York. Tom McLeish has a B.A., as well as a Ph.D. in fluid dynamics, both from Emmanuel College, Cambridge.

### **Evolutionary compromise**

However, McLeish is a trustee of the John Templeton Foundation, well known for promoting theistic evolution. As such, it is no surprise to find that the authors adhere to secular thinking about the beginning of the universe and age of the earth: “the big bang theory, an idea which now dominates our thinking about both space and time” (p. 36). They consider Genesis as “one of the Bible’s many creation stories” (p. 189) and “[t]here are many creation texts of many different genres within the Bible, but one is by far the best known—that of Adam, Eve and the

garden of Eden” (p. 103). These statements downplay the fact that Genesis is the primary *historical* account of creation in Scripture; other creation texts (e.g. Psalm 104, Proverbs 8, and Job 38) are not creation *accounts* aiming to describe what happened.

### **Christian roots of science**

All 10 chapters start with two quotes which set the scene for the chapter on hand (seven chapters include one biblical quote). A large portion of *Let there be science* is devoted to a review of science history, including the roles played by Bible-believing Christians (and creationists!), such as Faraday, Maxwell, Newton, and others.

To identify the practice of science throughout history, the authors outline three distinct criteria of true science (p. 31):

1. There must be observation of something in nature,
2. There must be a discussion of a possible physical cause,
3. There should be some form of analysis or testing involved (through planned experiment, physical interaction, or by further observation).

Using these tenets, they find people practising science long before most people would expect—much further back than just a few centuries. They even identify Jesus using this scientific outlook 2,000 years ago! In Mark 7:14–19, Jesus contrasts a physical fact (food entering the stomach and being expelled) with a theological point, that things from outside cannot defile a person. Science—the digestive system—and faith—(im)morality—are linked together in one argument (p. 40).

Back still further (c. 580 BC) we pass Daniel, Hananiah, Mishael, and Azariah who ask the powers that be to “treat your servants in accordance with what you see” (Daniel 1:12–14).



This is an invitation to test and observe (p. 41).

One example further back again is given: Gideon (1150 BC) and the fleece. The first night Gideon requests that the fleece will get wet but the ground dry. The second night he requests the reverse, that the ground will be wet and the fleece dry. He observes it is so and is confident that God is the cause: of his observations as well as the instructions to bear arms and fight off the oppressors (p. 42).

All this shows that “science has thrived, for millennia, in the presence of belief in the Biblical God” (p. 45). They also show what ought to be “the calling on scientists: follow the evidence” (p. 84). Indeed, this should apply irrespective of whether you are a Christian or not. Accusations are commonly hurled to and fro that the other side is not doing so. However, for a Christian to not follow the evidence is to live in contradiction with the biblical worldview: to be truthful and to follow truth (Exodus 20:16; John 14:6). But what if non-believers find any inconvenient truths about their worldview? Are they willing to admit that they have to change their idea? Apparently so, as long as it does not lead to God and Jesus.<sup>1</sup>

### Science stifled

Paradigms can get in the way of science. The authors tell the story of Hungarian doctor Ignaz Semmelweis (1818–1865) of the Vienna General Hospital, who mandated handwashing before treating a patient. There was an immediate effect: the death rate of women dying after childbirth dropped significantly. Unfortunately, pride and ignorance got the better of Dr Charles Meigs, who said something along the lines of, “gentlemen’s hands are always clean” and therefore did not comply. Many others joined ranks with Meigs’ feigned innocence. As such, mother and baby mortality rates increased again, despite the proven success of the newly introduced hand hygiene policy (pp. 89–91).

However, the authors’ belief in evolution and billions of years also partly hinders science. Science (Latin: *scientia*) originally meant knowledge in general. God, who is omniscient—which both authors would acknowledge—is also the One who gave the revelation of the Bible, starting with the creation account followed by the Curse, due to the Fall. Adam and Eve “are portrayed as being part of a flawless natural world [emphasis added]” (p. 103). They were “portrayed” that way because they *were* a part of a world without sin and suffering before the Fall. However, when the authors cover Genesis 3, they emphasize the relation between humankind and nature, instead of the problem of sin and thus death:

“Previously, Adam and Eve had lived in peace with nature; now their coexistence would be a struggle. The relationship between humans and the creation around them was now damaged. As a result, theirs would be a fight to understand it, a fight to benefit from it and a fight to enjoy it.

“Wisdom about nature would have to be hard won: it would be *painful toil*. In this same passage, though, God ensures that Adam

and Eve are not left without hope. He hints that, one day, a decisive victory for humankind will be won over evil [emphasis in original]” (p. 103).

None of this is wrong *per se*, but the authors fail to mention how Genesis 3 deals with “the last enemy”: death (1 Corinthians 15:26). Of course, adherers to long ages—before Adam was around to disobey God—don’t like to talk about death. It is a massive theological problem for them. It is noteworthy the authors quote Robert White’s book *Who is to blame?* (p. 123): “Natural processes such as earthquakes, volcanic eruptions, floods and the natural greenhouse effect are what make this world a fertile place in which to live. Without them, it would become a dead, sterile world and no one would be here to see it.”<sup>2</sup>

After all, they agree with White: “The Bible teaches that God has made a world in which uncertainty and chance—from our point of view—operate at local level in order to produce a functioning, habitable world overall” (pp. 123–124). However, Jesus mentions earthquakes together with wars, tumults, famines, and pestilences (Luke 21:9–11) and instructs us not to be terrified. These clearly were not part of the natural order, as God created everything very good. Rather, these are consequences of the Fall in Genesis 3.

### Concluding remarks

The final pages of the book demonstrate that Christianity is not a blind faith. First, that the Bible itself is compatible with our experience of this world. Second, that many scientific giants were in fact Bible-believing Christians. And third, that the alternative position is far from persuasive. “If there is no God, and our brains are the product of pseudo-directed randomness, how is it that we can trust them?” (p. 171). This alternative leaves us “with no other option but to exercise *faith* ... in ourselves, and ... it is, by

definition, *blind* [emphasis in original]” (p. 171).

However, the authors don’t recognise that they (in some ways) have put their faith in people above the Holy Spirit.

“Nowadays, clever use of technical scientific jargon can close down conversation or even enable dishonest pseudo-scientists to exploit the masses—who often feel hopelessly out of their depth. In the past, public ignorance—or even lack of access to—the Bible left the door open for dishonest pseudo-priests to do the [*sic*] exactly the same with their congregations” (p. 179).

They refer to people like David Wilkinson and Francis Collins as reliable guides who know science and the Bible very well. Both have questionable theological views, similar to those held by the authors (one of whom is mentioned along Wilkinson and Collins).

All in all, *Let there be Science* is not a bad read. However, apart from some specific historical events in the scientific world it does not really offer anything new. The departure from biblical creation by many is also apparent here. Although not rife throughout this book (e.g. pp. 36, 48, 119), let it serve as a notice for those wanting to read this little volume—or other works by either of the authors—for themselves: *caveat lector* (reader beware).

### References and notes

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# The unexpected history of scientific naturalism

## ***Science Without God? Rethinking the history of scientific naturalism***

Peter Harrison and Jon H. Roberts  
(Eds)

Oxford University Press, Oxford, UK, 2019

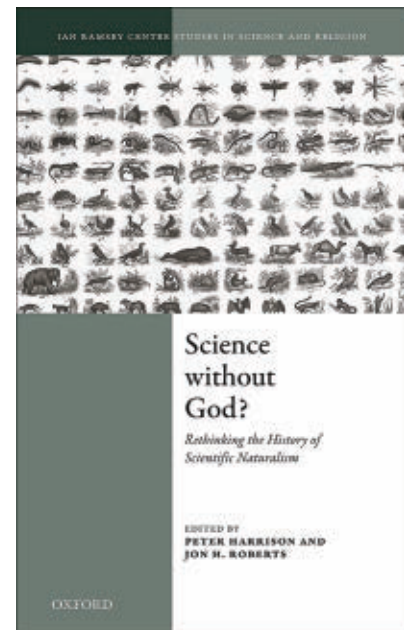
Daniel Davidson

In debates about science and religion, ‘naturalism’ is a recurring subject of discussion. As it’s usually explained, ‘scientific naturalism’ refers to a commitment on the part of scientists to look only to natural causes to explain phenomena under discussion. That is, one should employ only natural and *not* supernatural explanations. Secular scientists and historians alike have long assumed that modern science as such developed hand-in-hand with scientific naturalism. They believe, in other words, that science progressed as researchers learned to eschew the temptation of falling back on supernatural explanations: rather than attribute fossils to the caprices of the gods, study geology and learn how animals can naturally fossilize; rather than insist that the heavens are the realm of divine perfection, look through a telescope, see the craters on the moon, and study how they got there. And so on. Secular apologists take a lesson from this story about the advance of science: religion holds science back; science progressed as religious influence on science declined. On this account, the history of science is a secular morality tale about the importance of naturalism and the negative influence of religion.

But the best historians of science today know that this secular morality

tale is bad history. In *Science without God?*, 13 historians of science come together to consider the sometimes surprising relationship between naturalism and religion in the history of science. The book is edited by two eminent historians of science: Peter Harrison (now at University of Queensland after having previously held a professorship of science and religion at Oxford) and Jon Roberts (Boston University). The book’s contributions span a vast chronological scope and range of sciences, from the ancient Greek philosophers to Newton and the scientific revolution, to the origins of modern psychology in the early 20<sup>th</sup> century. It is a work of historical scholarship that captures a lively conversation among outstanding historians of science. Christian apologists will appreciate the fact that the contributors mostly agree on the basic point that the simple secular morality tale of history is wrong.

What goes in place of the now-debunked secular morality tale version of the history? What do the best historians have to say about the relationship between religion and naturalism? On that issue, there’s less agreement—that varies at different times and places. The closest thing to a consistent theme in the historical accounts presented in this book is a thematic interest in finding the unexpected twists and turns of the relationships between science, religion, and naturalism. Some of the chapters argue that periods in the history of science that are commonly thought of as highly secular and naturalistic are not. Other chapters argue that the turn to naturalism was itself (sometimes) motivated by religious reasons. Still others document the coexistence of religious commitment and naturalism.



Each contributor has a different perspective and narrates a different historical episode. Together, this book presents a set of historical episodes, and conversations about how to interpret the history, that rewards a thoughtful reading by any Christian interested in the relationship between science and biblical faith.

## **A word about terminology (and apologetics)**

Before getting into the contents of this book, it’s worth clarifying the terminology and also the biblical creationist position on the theory of naturalism. A commitment to scientific naturalism can come in two varieties: “methodological naturalism” and “metaphysical naturalism”. “Methodological naturalism” means that naturalism is a commitment for scientific method. But it leaves open the possibility that non-naturalistic forces actually exist and that non-naturalistic explanations might be appropriate in other contexts (such as origins). Metaphysical naturalism, by contrast, is a commitment to the idea that nature is all that exists in all of reality—a

commitment incompatible with religious belief. (All metaphysical naturalists are also methodological naturalists, but not the other way around.) Even the most liberal theistic evolutionist ultimately has to reject metaphysical naturalism. In *Science without God?* the reference to naturalism is really to methodological naturalism throughout—but always alert to the possibility that increasing methodological naturalism might aid and abet the cause of metaphysical naturalism, even if the former doesn't necessarily entail the latter.

A casual observer might think that biblical creationists and Intelligent Design (ID) proponents would reject even the less-robust methodological naturalism. This is true but needs to be carefully qualified. Yes, creationists and ID proponents believe that it's appropriate to explain features of the natural world by reference to supernatural design. But the biblical creationist position is subtler than a simple assertion that God directly intervenes in creation. The biblical position does indeed reject a thoroughgoing methodological naturalism and instead affirms that divine design (and judgment) is responsible for important aspects of the natural world. But the biblical position also affirms that God generally works through regular processes of nature. Miracles are rare interventions and not the whims of a capricious God. The biblical creationist can thus insist that we don't—and shouldn't—invoke a 'God of the gaps' to explain every difficult question that we find in His created world.<sup>1</sup>

With this in mind, we can turn to consider some of the thought-provoking history in *Science without God?*

### Looking for naturalism in the wrong places

The book starts with the ancient classical philosophers whose work on the observation and interpretation of natural phenomena is often hailed as the earliest beginnings of natural

science. The standard story here has long been that the Greeks made the crucial move. For instance, it was in classical Greece that one can find a shift from weather being explained as the activity of the gods, to the assertion that lightning and thunder are caused by the natural force of "wind" (as Anaximander says). This is the much-hailed shift from superstition to naturalism.

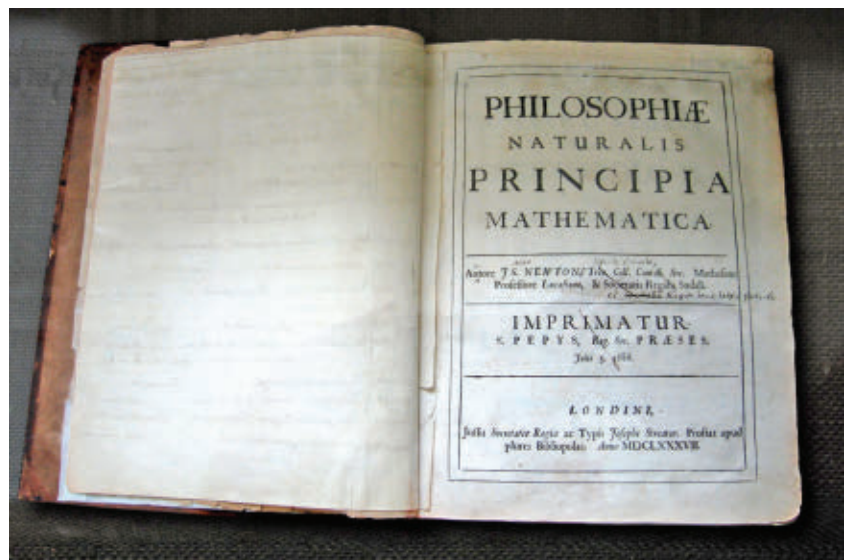
In his chapter reconsidering classical science and naturalism, Daryn Lehoux (Queen's University, Ontario) documents that a great many of these supposedly naturalistic proto-scientists in fact remained committed to a deeply religious cosmology. The list includes Ptolemy, Aristotle, Pliny, Cicero, and many more. None of the major thinkers clearly demarcated the natural world from the influence of some sort of supernatural entity. Few indeed are the ancients who actually moved to full-blown metaphysical naturalism and denied the existence of gods *in toto*.

Lehoux helpfully notes that it hardly makes sense to ask what it would mean to the ancients to demarcate a domain

of 'scientific naturalism' as distinct from the domain of the 'supernatural':

"After all, if we define science as the domain of the natural and label one set of causal agents as by definition *beyond* that domain—*super* it, in the Latin—we are certainly setting up a clear demarcation, but at the non-trivial risk of begging the question. Or perhaps the gods are just part of the natural domain in the first place. If we try to refortify the natural-supernatural distinction by now arguing that the gods as causal agents do not, in point of fact, exist (or more cautiously, have never been proven to exist), we simultaneously close off a considerable portion of what we might otherwise want to accept as historical science, pre-modern as well as modern, since so very many historically posited causal entities turn out to be just as non-existent: N-rays, phlogiston, psychic pneuma—the list is endless" (p. 21).

The modern idea of scientific naturalism just didn't exist in any meaningful sense among the classical naturalists.



**Figure 1.** Isaac Newton's own copy of his *Principia*. Newton was not a modern philosophical naturalist but believed that science, natural law, and divine action were compatible, as contributors to *Science without God?* document. The longstanding association between 'Newtonianism' and naturalism was a product of later Enlightenment secularists who worked hard to reinterpret Newton in support of their position.

Image: Andrew Dunn / CC BY-SA 2.0

Peter Harrison gets to a similar bottom line in his fascinating account of natural-law thinking among leaders of the scientific revolution. The laws of nature articulated most famously by Newton are often thought of as foundational for scientific naturalism. With natural laws recognized, there's less need for divine intervention and the whole machine of nature can go on its own. Or so goes the standard story. Harrison argues persuasively that this is quite wrong. Instead, Newton, Boyle, and Descartes all believed that the laws of nature were regular and reliable precisely because of God's direct engagement with the world.

Newton and Descartes reasoned about God's relationship to the laws of nature in quite different ways, to be sure. Descartes started with the regularity of God's actions as his premise and that allowed him to conclude that the natural laws established by God could be relied upon. Newton started with the observation of the laws of nature and concluded that, from this observation, we could (in Harrison's words) "arrive at conclusions about God" (p. 64). "Newton has accepted that there are laws of nature but proposes that these are freely chosen by God, and these choices attest to the wisdom of their divine source" (p. 64). Newton criticized Descartes for creating a system which could be understood as God setting up laws and letting nature go on its own. But Descartes just saw a different place for the operation of God's direct intervention to undergird laws of nature. In ancient classical ideas about the laws of nature, Harrison notes:

"... nature had usually been understood as governed by the internal properties or essences of natural things, even if these internal tendencies had been implanted in things by God. In Descartes's mechanical and atomistic world, however, natural things are essentially inert, and are moved according to external laws imposed directly by God" (p. 62).

Both of these approaches require a creator God. And not just a one-time deistic creator who then leaves his creation to run autonomously on natural laws, but an *active* Creator who is (in one way or another) involved in maintaining His creation on an ongoing basis. At least in this conclusion, Descartes and Newton, each in his own way, put forward ideas that fit well with biblical teaching. Jesus Christ "upholds the universe by the word of his power" (Hebrews 1:3); "in him [Christ] all things hold together" (Colossians 1:17).

Newton's rejection of naturalism doesn't stop there. Harrison argues that Newton went beyond this commitment to God-sustained natural law to a belief in an apparently non-law-based direct intervention of God in the solar system. In 1694, mathematician David Gregory reported that Newton said: "that a continual miracle is needed to prevent the sun and the fixed stars from rushing together through gravity" (p. 67). This particular point is controversial as an interpretation of Newton's thought.<sup>2</sup> But Harrison makes his case that this is indeed compatible with what we can learn from Newton's own writings. It is hard to imagine anything further from modern "scientific naturalism", with its sharp demarcation between science and religion.

### A campaign for naturalism

Harrison's account doesn't absolve Newton and Descartes from a role in the development of modern scientific naturalism. It instead sets up the next step of the story: these heroes of the scientific revolution (Newton particularly) were important figures in the later development of naturalism, but thanks to a distortion of their views. The conclusion of Harrison's chapter and then a full subsequent chapter by J.B. Shank (University of Minnesota) both describe how individuals following Newton used and misused natural

law as an excuse for reducing the role of God in accounts of the natural world. While the "Newtonian scheme" had been intended to "assert the ubiquity of divine power and to 'super-naturalize' the whole cosmic order", Harrison notes that Newton's approach could be—and was—reframed in "a purely naturalistic reading". God was simply dropped from the account of natural law, laws were said to run on their own, and the scope for non-law-based "miracles" was contracted every time science made an advance in understanding. In a development that would doubtless have appalled Newton himself, Enlightenment natural philosophers appropriated Newton's enormous prestige to support a naturalism in which God appeared to be an unnecessary hypothesis.<sup>3</sup> Shank charts the fight over Newton's legacy in a fascinating chapter that shows how history can become a battleground: over the course of the 18<sup>th</sup> century, Christian natural philosophers struggled with materialists over the meaning of Newton's legacy. "Newton's 'Newtonianism' and the one which came to be held by many across Europe by the end of the 18<sup>th</sup> century were two very different things," Shank explains (p. 96.) Contrary to long-accepted wisdom, "Newton's pioneering work was anything but a direct agent in the Enlightenment's isolation of cosmological science from God and religion" (*ibid.*); instead, his appropriation by the Enlightenment secularizers was the product of a self-conscious, intentional campaign to claim Newton for naturalism (figure 1).

Naturalism as a sharp delineation of divine activity from the realm of science became a larger issue from the Enlightenment on. But it wasn't one of natural association between science and naturalism. To the contrary, the lines between scientific research and belief in divine intervention in nature remained fluid and contested in a great many fields. John Hedley Brooke describes the history of chemistry as



one of ongoing fights over the theological implications of this scientific field. Nineteenth century Christians saw in chemistry a lesson about God's incredible design, proven by His ability to make living systems out of elements as unlikely as carbon, hydrogen, oxygen, and nitrogen (p. 120). Materialists and

positivists, on the other hand, would refer to the science to support reductionist accounts of the world, with matter and chemical reactions the building blocks that had no need of God.

Sometimes the turn to naturalism had even stranger and more surprising twists. In 17<sup>th</sup> and 18<sup>th</sup> century

England, for instance, a group of heterodox professing Christians argued for a materialist account of the soul. A fascinating chapter by Michelle Pfeffer (Queensland) describes this forgotten argument. Growing out of the ferment of radical religions in the 17<sup>th</sup> century, these materialists argued that the Hebrew Scripture supported their position and that the concept of an immaterial soul was a Greek corruption of the biblical idea. They were not particularly important figures in the history of science. But they were a reminder that nothing can be taken for granted in historical study, not even the idea that materialism is always associated with unbelief.

### Naturalism by happenstance

Naturalism wasn't always intentional. A chapter on the medieval period by Michael H. Shank (University of Wisconsin) reveals a sharper demarcation between the study of science and the study of religion. This was not due to a lack of religious commitment by medieval scholars. Rather, Shank argues, this demarcation came about as a matter of university governance. Ecclesiastical authorities ran virtually all schools in Europe until the first universities were created in the late 12<sup>th</sup> century. Medieval universities were divided into semi-autonomous faculties. The faculty of arts was able to preserve its autonomy from ecclesiastical control by carefully self-policing the subject matter fit for scholarship and discussion. Avoiding theological disputes enabled the arts faculty to avoid oversight or interference by church authorities. So it became institutionally important to emphasize that the study of (say) Aristotelian physics or astronomy was not related to theological inquiry, that it was possible to proceed *de naturalibus naturaliter*, '[to treat] the natural naturalistically' (Albertus Magnus, quoted on p. 38). The medieval scholars emphasized the lawlike



**Figure 2.** Fourteenth-century scholars hard at work at the University of Paris. A chapter in *Science without God?* argues that one source of naturalism was a happenstance of institutional politics in medieval universities, rather than a deeper philosophical commitment to separating science and religion.

regularity of nature, which helped them to defend their position that they could work on ordinary occurrences in nature without trenching on the domain of theology. Sometimes this argument led the medieval scholars to minimize the truth claims of Scripture or theology about the natural world, as Shank documents. For instance, 12<sup>th</sup> century scholar William of Conches interpreted Genesis 1 as declaring (in Shank's words) "the existence of various beings (the facts) without explaining how they came into being (the causes). William therefore insisted that, by supplying the missing causal explanations, the natural philosopher ... could not possibly be doing anything contrary to Genesis" (p. 41). Shank's main point here is that the link between naturalism and scientific explanation wasn't a necessary condition for doing science. It was instead a highly contingent development in which institutional politics happened to promote a particular perspective on the science-religion relationship (figure 2).

### Darwin and naturalism

The chapter on Darwin and naturalism is written by the prolific Michael Ruse, not a historian but a philosopher. More than other chapters, this one affirms a standard view about the history of naturalism: Darwin did take a significant step toward removing God from biology by enhancing the status of naturalism in the discipline. Ruse goes so far as to quote the atheist Richard Dawkins favourably (Ruse has often disagreed with Dawkins in print): "Until Darwin, it was impossible to be an 'intellectually fulfilled atheist'" (p. 134).

Yet in keeping with the revisionist spirit of the rest of the book, Ruse doesn't stop there—he wants to complicate the picture somehow. He notes that Darwin was a believer in 'God' at the time he wrote *Origin of Species*—a deistic god, but a god nonetheless.

Ruse also points out that Darwin's research agenda was one that grew from the Christian culture: Darwin searched for a final cause because that was what natural philosophers in the Christian tradition did. It just so happened that Darwin chalked up to nature many things that had previously been attributed to a designer. Ruse makes much of the structural similarities between Darwinian evolutionary thought and Christian thought about the origins and development of biology. (It's a theme he previously developed at length in a book.<sup>4</sup>) In the end, this is really just a way of noting that the Darwinian argument was quite forceful in replacing Christian concepts about biology with secular, naturalistic ones: divine creation and providence replaced with a story about naturalistic but progressive evolution. But is a belief that evolution is 'progressive' really justifiable based on the observation of nature? Ruse concludes that it isn't—it is instead an item of faith. Ruse is obviously drawn to an ideology of progress as a kind of faith commitment, but he recognizes that he can't really justify the move on the empirical evidence alone.

If Ruse's chapter on Darwin is relatively weaker than others on disrupting accepted narratives about naturalism, this is also notable in a different way. For the Christian apologist, it drives home the point: Darwin is especially problematic precisely because he played this important role in the cause of naturalism and the replacing of Christian belief in design and providence with a secularized faith in progressive evolution.

### A resource for historians of science and Christian apologists

As the editors of this fine collection, Harrison and Roberts are to be commended. The contributions are on the whole successful in combining fine scholarship with an accessible

presentation and united around the coherent theme (scientific naturalism). Such coherence and unified presentation is not something to take for granted in an edited collection. Nor is the overall quality of the prose in an academic volume. One could quibble about points of emphasis. While most of the chapters are easy to see as participants in the same dialogue, a few chapters (on biblical criticism, anthropology, psychology, and the obscure quasi-Christian materialists) stretch the conversation in new directions. Depending on one's perspective, this might or might not be viewed as a valuable move. Historians might appreciate the broadening of the conversation while people reading for contemporary apologetic relevance will likely find these less immediately useful. In any case, this is a thought-provoking resource for both the historians of science and more generally for Christian apologists. For the apologists, this provides outstanding scholarly resources with which to answer the skeptics who believe that the history of science requires naturalism in order to succeed.

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# Adam and Eve in historical survey—learn but be leery

## *The Rise and Fall of Adam & Eve*

Stephen Greenblatt

The Bodley Head, London, 2017

Philip B. Bell

Reading the title of this book, one might expect the author to be a scientist with Christian beliefs, or else a theologian. Stephen Greenblatt is neither, rather a historian and Harvard University professor, distinguished for his non-fiction literary works by such awards as the Pulitzer Prize (2012) and the Holberg Prize (2016).<sup>1</sup> And *The Rise and Fall of Adam & Eve* (hereafter RFAE) is certainly a very satisfying read from a literary standpoint. But what made Greenblatt tackle this subject, and does it add anything useful to the burgeoning pile of books on the subject?

While not mentioned in the book, Greenblatt is known as one of the founders of a literary theory called ‘New historicism’ (a word he coined in 1982<sup>2</sup>), a sort of postmodernist approach to interpretive history, thus germane to the author’s treatment of Adam and Eve. One suspects that the ‘new historicism’ is not so new, and it raises the spectre of a materialistic ideology influencing Greenblatt’s work under the guise of literary objectivity. Certainly, he does approach the waxing and waning of belief in Adam and Eve as largely influenced by the social and political milieu of the times in which various commentators on Adam and Eve lived—whether theologians, philosophers, poets, or artists.

Writers like Greenblatt himself, of course, are not immune to the

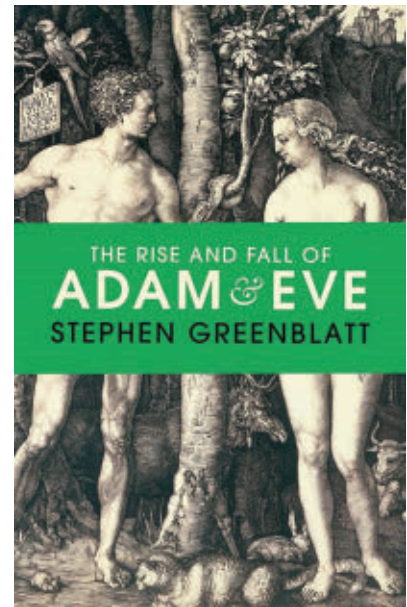
contaminating influences of today’s culture, which should be borne in mind when reading masters of literary prose, whose ‘power of writing’ can seduce the unwary. This warning sounded, RFAE—divided into prologue, 14 chapters, an epilogue, and two appendices—is a valuable addition to the recent treatments of Adam and Eve.

Why is the story of Adam and Eve so enduring? Greenblatt denies the historicity of the Genesis account of their origin but he does believe we are made in the story’s image. He rightly points out that it has shaped how people view morality, ethics, crime, punishment, pain, death, sexuality, marriage, leisure, and more. Indeed, there is much to commend in RFAE, which is far from a simple rehash of topics covered frequently elsewhere—and is all meticulously documented.<sup>3</sup>

## Texts and tablets

Unfortunately, however, the latter does not hold true for chapters two and three. Greenblatt accepts the modernists’ claims that the Pentateuch dates to the sixth century BC. While acknowledging that this is controversial and that he is not qualified to defend or critique this position, he does not let this prevent him from retelling the higher critical story of how the Hebrew exiles supposedly developed the ‘Mosaic’ writings in their Babylonian captivity, influenced by such texts as the *Enuma Elish*, “with its praise of Marduk, who created the first humans” (p. 33). This holds that in order that the God-fearers among the Hebrews might keep people true to Jehovah, they changed the stories as needed (including that of Adam and Eve).

Tediously, he outlines Julius Wellhausen’s documentary hypothesis with



its alleged redaction of four document strands (J, E, D, P), concluding that it is no longer tenable to insist that Moses authored the early chapters of Genesis. Instead, someone in Babylon (the ‘Genesis storyteller’) pulled together all the stories of the time to create a Hebrew counter-narrative. Moreover, “Yahweh was ... the Genesis storyteller affirmed, the Creator of the universe; he was everywhere and all-powerful” (p. 38). He goes on to recount the discovery of various clay tablets (notably *Gilgamesh*) that informed and reinforced modern scholars in their prejudiced view of Genesis; this review passes over these well-trodden paths of enquiry.

Perhaps less familiar to some readers of this journal are the ancient texts that Greenblatt delves into, such as the cache of ancient Coptic texts (discovered in 1945) known today as the Nag Hammadi Library. For example, the *Apocalypse of Adam* professes to be Adam speaking to his son Seth, while *The Testimony of Truth* is written from the Serpent’s perspective. Greenblatt seems particularly taken with *The Life of Adam and Eve*, a Greek text which began doing the rounds in the first century. With many imagined scenes that are absent from the Genesis record, it



was never part of the ‘biblical’ Apocrypha, let alone considered as a candidate for the scriptural canon. Unsurprisingly, Greenblatt views Genesis as just another ancient literary account, believing the ‘elaborations’ contained in *The Life of Adam and Eve* satisfied people’s craving for more detail.

His tour of ancient texts covers rabbinical commentators, such as Rabbi Samuel ben Nahman (third century AD), early Muslim ideas, the heretical antisemitic bishop Marcion (born c. AD 85) who taught that Yahweh was indeed Creator but an evil one, and Irenaeus’s *Against Heresies* (AD 180), which countered Marcion and his followers. Irenaeus made clear that “Christians were not permitted ... to forswear the story of the first humans. No Adam, no Jesus” (p. 75). Less well known is the fact that Roman emperor Julian “the Apostate” (fourth century AD) derided the story of Adam and Eve. In his *Against the Galileans*, he saw the serpent as benefactor rather than destroyer.

Greek-speaking Jewish philosopher Philo (c. 20 BC – 50 AD) was perhaps one of the earliest advocates of an allegorical view of Genesis, influencing the famous early church scholar Origen (c. AD 184–253). While arguably reverential of the Adam and Eve account, Origen’s ‘interpretations’ sound as absurd to many Christians today as doubtless they did to many of his contemporaries—such as ‘Eden’ representing Jesus Christ, or ‘the woman’ conveying sense perception. But is the lack of traction of Origen’s fanciful ideas a sufficient explanation for the endurance of the literal understanding of Genesis?

### Saints and sinners

Noting that surveys confirm millions of people still profess belief in a literal Adam and Eve, Greenblatt stops short of saying that this is through ignorance, although he believes it to be *contra* scientific evidence.

Why then the persistence of a literal understanding? An interesting excursus on the life of Augustine of Hippo (AD 354–430) attempts to inculcate readers with the ‘Augustine originated Original Sin’ view. Supposedly, Augustine managed to convince himself of the literal truth of the Adam and Eve story, and, “Through intellectual mastery, institutional cunning, and overpowering spiritual charisma, this one man managed slowly, slowly to steer the whole, vast enterprise of Western Christendom in the same direction” (p. 97). Greenblatt works hard to build his case that the Fall is a legacy both of Augustine’s preconversion experiences of sexual arousal and misconduct, and his post-conversion over-thinking and theorising.

Certainly, theistic evolutionists are fond of claiming that the doctrine of Original Sin was invented by Augustine. Yet he himself was aware of this deceit, protesting:

“It is not I who made up original sin! The catholic faith has believed it from its beginnings. But you who deny it are undoubtedly a new heretic.”<sup>24</sup>

Greenblatt argues that Augustine was motivated by the fact that he didn’t want to live in a universe in which there was no reckoning of moral behaviour, whether punishments for wickedness or rewards for piety. Be that as it may, he correctly shows that the hard truth of a human’s moral wrongness from birth was a cornerstone of Christian orthodoxy. Predictably, we read of the contrary views of Pelagius (AD 354–418) and of his followers (like Julian of Eclanum), plus Augustine’s retorts; an engaging discussion nonetheless.

### Misogyny and marriage

Another thread in Greenblatt’s picture of the history of Adam and Eve is the way in which thinkers perceived and portrayed Eve: merely ‘the weaker vessel’<sup>25</sup> or, as second-century theologian Tertullian taught, ‘the devil’s

gateway’ (p. 122), guilty of a greater wickedness than Adam for having followed the enticements of the serpent. Augustine’s contemporary, Jerome (AD 347–420), went even further and seems to have disparaged marriage. For a time, the view that marriage was as holy as virginity was deemed by some a punishable heresy, this in spite of the fact that the Genesis account seems to be “an ecstatic celebration of marriage” (p. 124) as one Christian writer of the times, Jovinian, believed. Jerome wrote *Against Jovinian*, adamant that Eve’s role in the Fall meant that women were rightly to be ruled over by men (cf. Genesis 3:16). Greenblatt’s ensuing discussion of how this tension developed is fascinating. He does grant that Christians over the centuries generally believed Adam to be the more culpable of the pair since he had transgressed God’s command *wilfully* (1 Timothy 2:14).

### Aesthetics and politics

RFAE has two sections of glossy colour plates (29 images) depicting how Adam and Eve have been variously depicted through the ages in sculptures, reliefs, paintings, sketches, and frescos. This certainly adds some dimensions that are rarely addressed, one of which might be summarised as ‘nudity or prudity’—Adam and Eve’s nakedness displaying the glorious innocence of their perfect pre-Fall bodies, or else tastefully obscured by well-placed shrubs or leafy branches. Was marital sex solely/primarily for procreation? What of the design for intercourse in the pre-Fall Eden? Many thinkers mulled over these things, as Augustine had done.

A chapter entitled ‘Chastity and its discontents’ further develops these murmurs of uncertainty about human sexuality. It is a biographical sketch of famed English poet John Milton, a contemporary of many Puritan theologians. Greenblatt views Milton’s *Paradise Lost* (1667) (figure 1) as “the

greatest poem in the English language” (p. 163). It is surely uncontroversial, he suggests, that Milton’s own high ideals, coupled with his rather disastrous experience of wedlock, greatly coloured his views of women and marriage. Milton’s pamphlet *The Doctrine and Discipline of Divorce, Restored to the Good of Both Sexes* (1643) was incendiary, some considering his arguments blasphemous.<sup>6</sup> Actually, Milton’s first marriage did not end in divorce, but Mary Milton died shortly after the birth of their fourth child in 1652—just 27 years old.<sup>7</sup> Doubtless, however, the published views of someone of Milton’s stature carried influence.

Those were heady times, with civil wars across England (collectively the English Civil War) between 1642 and 1651. Upon the execution of Charles I (30 January 1649), the irrepressible Milton was quick to publish another polemic condemning ‘the divine right of kings’ and arguing that “All men naturally were born free, being the image and resemblance of God Himself” (p. 193)—Genesis employed as political statement. Others on the

Parliamentarian side were also pleased to appropriate the early chapters of Genesis for their times:

“On April 1, 1649, [Gerrard] Winstanley led a small group of like-minded men and women to dig and plant crops on St. George’s Hill in Surrey, about twenty miles from London. They were Adam and Eve, their leader said, and together they would re-create the Garden of Eden” (p. 194).

Similarly, Winstanley recast the Fall for their post-monarchy period.

Milton, who seemingly admired Winstanley, accepted a responsible position within the new ‘Republican Council of State’ and became a European champion of Parliamentary rule. Consequently, upon the restoration of the monarchy under Charles II (29 May 1660), Milton was forced into hiding for many years as a traitor. Greenblatt outlines other features of Milton’s life—including two more marriages, the effective estrangement from some of his children, his blindness from 1652—and traces these influences through to his publishing triumph, *Paradise Lost*.

or allegorical emblems of humanity as argued by certain writers.

Likewise, with the establishment of the Fall as a real historical event. Milton’s machinations, motives, and methodology within *Paradise Lost* are intriguing, and Greenblatt’s thesis merits reading. But how to answer the question that intrigued Isaac La Peyrère (1596–1676)<sup>8</sup>, “Where ... did the woman Cain married come from? The traditional answer, scandalously enough, was that she was one of his sisters, though no daughters of Adam and Eve had been mentioned up to this point in Genesis” (p. 232). It would be prosaic to respond to this time-worn question here but suffice it to say, this question is the author’s cue to introduce ideas of other “Men before Adam” (chapter 12).

European explorations of the New World led to encounters with ‘primitive’ tribespeople whose state of apparent innocence seemed reminiscent of that of Adam and Eve—at least to some colonists and chroniclers. Bartolomé de las Casas, writing in 1542, agreed with Christopher Columbus that the Americas were likely where the lost Garden of Eden might be found—and thought the victims of the Spanish conquests there resembled our first parents. For La Peyrère, the diversity of human beings—including “the fashionable ladies of Paris and the naked natives of the New World” (p. 237)—was a formidable challenge to the credibility of Genesis. Certain Greek philosophers of the pre-Christian era (such as Epicurus and Lucretius, even Plato) had already proposed evolutionary ideas of civilized humans developing from savages. La Peyrère believed Adam and Eve had by no means been the *first* humans. Long before their Fall, there were other humans struggling to survive, enduring famines and plagues, painful childbirth, ending in death—he published his ideas about ‘pre-Adamites’, first in Latin (1655), then in English, as *Men before Adam* (1656).<sup>9</sup> “If so few readers of the Bible have understood these

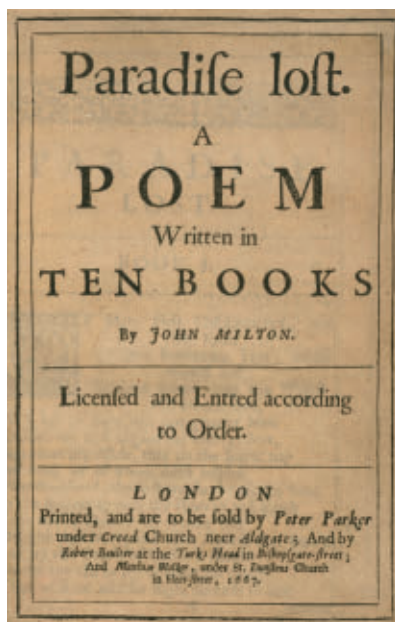


Figure 1. Englishman John Milton’s *Paradise Lost* (1667)

### Paradise and pre-Adamites

For Milton, as Augustine, the Genesis record of human beginnings was absolutely key to sound faith and ethics, but also to human psychology, anthropology, and politics. Moreover, “the literal truth of Jesus Christ was bound up with the literal truth of Adam and Eve. The Savior’s actual blood canceled the debt incurred for all of us by the actual transgression of the actual first humans” (p. 205). Greenblatt insinuates that Milton sought to rival the stature and motive of other great poets: Homer (in his *Iliad*) sought to make the Trojan prince Hector real, while Virgil toiled to bring Aeneas to life (in *Aeneid*). In like manner, he reasons that *Paradise Lost* was Milton’s extravagant attempt to vivify Adam and Eve, no longer the ethereal beings

simple truths, it is, La Peyrère wrote, because the Bible is such an imperfect document” (p. 243).

Less well known is that La Peyrère believed in a coming Jewish Messiah through whom all people, descended from Adam *and* from pre-Adamites, would be saved. Regardless, Protestants, Catholics, and Jews alike roundly condemned his book and La Peyrère was forced by the authorities in Catholic Brussels to publically recant his views (1656). Greenblatt adds the interesting comment that “His notion of multiple human origins—polygenesis, as opposed to monogenesis—gave the racists just what they needed” (p. 248).

### Falling and doubting

The ‘fall’ in the title of Greenblatt’s book is seemingly a double entendre, representing both the waning of belief in a literal account of Genesis, and especially Adam and Eve’s rebellious falling from innocence and perfection (Genesis 3). Greenblatt gives a historical overview of (dis)belief in a historical Fall, starting with Origen (AD 184–285). We read of French philosopher Pierre Bayle, whose best-selling *A Historical and Critical Dictionary* (first edition 1697, plus many more) increasingly eroded confidence in the historicity of Genesis; he struggled with why God permitted mankind to sin. The outspoken Voltaire (1694–1778) called the whole account a ridiculous lie, using his satirical wit to trash both Original Sin and the ‘Supreme Being’ in equal measure. By the late eighteenth century, churchmen were hastily retreating from a literal interpretation.

In the newly formed USA, both Bayle and Voltaire were admired by Thomas Jefferson (president 1801–1809), while most successors to the Puritan founders stuck to their guns on Original Sin. Mark Twain, a Presbyterian and Freemason, in his *Extracts from Adam’s Diary* (1892), used his

humourist talent to mock belief in a literal Adam and Eve; he later added *Eve’s Diary*. Holding back from publishing his full thoughts in his lifetime, posthumous pieces by him deny that Adam and Eve could have grasped God’s warning of the consequences of rebellion (Genesis 2:15–17), thus denying their culpability for sin.

Once Charles Darwin’s evolutionary ideology had gained a firm foothold, doubt about the historicity of Adam and Eve and the Fall were commonplace:

“Paradise was not lost; it had never existed. Humans did not have their origins in the peaceable kingdom. They were never blessed with perfect health and abundance, a life without competition, suffering, and death. ... Danger was rarely far off, and if they managed to hold the major predators at bay, they still had to reckon with army ants, and intestinal parasites, toothaches, broken arms, and cancer. ... As a species, humans were neither unique nor created once-for-all” (pp. 269–270).

Although Darwin’s *Descent of Man* (1871) makes no mention whatsoever of Adam and Eve, the Garden of Eden, or the Fall of Man, Greenblatt notes that Darwin was fully aware of the belief-destroying consequences of his theory of evolution. *Descent of Man* grappled with the very same questions about human origins.

The author of RFAE acknowledges that growing doubts and disbelief regarding the biblical origins account have greatly influenced today’s society. The acceptance of Darwin’s theory:

“... confirmed *the pagan intuition* that our earliest ancestors had no divine guidance, no assurance that their species would endure, no God-given laws, and no innate sense of order, morality, and justice. Social life as we know it, a life governed by a dense web of rules, agreements, and mutual understandings, was not a given but a gradual

achievement [emphasis added]” (p. 273).

Evidently, however, although Greenblatt approves of Darwin’s doubts concerning Genesis, he does appreciate the ‘myth’ of Adam and Eve for its influence of thinkers throughout the ages.

By all means, read RFAE but recall the warning given in the second paragraph of this review about the author’s worldview convictions. Yes, he finds the Adam and Eve story ‘fascinating’, even ‘indispensable’ for thinking about moral choices, temptations, sexuality, marriage, and death. Nevertheless, he celebrates that “The Enlightenment has done its work, and our understanding of human origins has been freed from the grip of a once-potent delusion” (p. 284). There’s much to learn here while being leery of the author’s underlying philosophical commitments.

### References

1. The Holberg Prize is an international prize with a monetary award of 6 million kroner, awarded annually by the Norwegian government—arguably the world’s most prestigious prize within the social sciences.
2. In his introduction in: Greenblatt, S., *The power of forms in the English Renaissance*, Pilgrim Books, 1982.
3. Indeed, the detailed chapter notes, bibliography, and index together comprise almost 100 pages on top of the 324 pages of the text proper.
4. Augustine, *Marriage and Desire* 2.12.25, cited in: Madueme, H. and Reeves, M. (Eds.), *Adam, the Fall, and Original Sin: Theological, biblical, and scientific perspectives*, Baker Academic, Grand Rapids, MI, p. 86, 2014.
5. 1 Peter 3:7, ESV, KJV; a literal translation from the Greek. NIV has ‘weaker partner’.
6. Initially published anonymously.
7. Milton was married twice more, first to Katherine Woodcock (12 Nov 1656 until her death on 3 Feb 1658), then to Elizabeth Mynshull (24 Feb 1663, until Milton’s own death on 8 Nov 1674), the last marriage reputedly an irenic one.
8. A trained lawyer and son of pious French Calvinists, he later turned to Roman Catholicism.
9. Grigg, R., Pre-Adamic man: were there human beings on Earth before Adam? *Creation* 24(4):42–45, 2002.



# Twelve rounds, twelve knockouts

## ***The Stairway to Life: An origin-of-life reality check***

Change Laura Tan and Rob Stadler  
Evorevo Books, 2020

Royal Truman

Those who believe evolutionary theories are scientifically implausible often argue in an unsystematic manner. Frequently a ‘one-punch knockout’ strategy is used, jumping from topic to topic looking for just the right line of reasoning to avoid effort. Therefore, Dr Tan and Dr Stadler offer a structured approach to the conflict, by breaking down the naturalistic approach to the origin of life into 12 discrete stages. The starting point for each presupposes the preceding ones are fully in place. Instead of providing a single-punch knock-out argument, their careful reasonings for each stage provide an arsenal of deadly martial arts techniques.

The book is quite extraordinary. It covers so much ground in such a short volume. The authors meticulously researched the facts, documenting their most important sources in 227 references, then present the essentials in a very concise and easily understood manner. Much of the content is explained so that a high school student could grasp the key message, but the world’s top scientists will also find much source of inspiration from examples they may wish to pursue in detail.

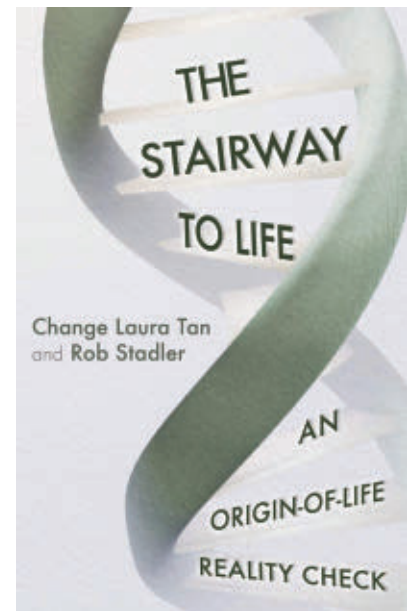
To illustrate how a great explanation clarified an otherwise challenging topic, a merry-go-round was used as an analogy for how the ATP synthase complex works (p. 157). Each child enters and holds on to an empty seat,

then contributes angular momentum when pushing off. Suddenly, everything made sense. This is quite a feat, considering that the simplest known ATP synthase consists of at least 20 interconnected proteins.

## **Abiogenesis research is intelligently performed**

Before introducing the 12 stages natural processes would need to resolve, Tan and Stadler discuss in detail a specific example of how a cell was allegedly manufactured in a laboratory. This helps to understand some key principles, such as the need for careful planning to ensure desired intermediate outcomes, based on pre-known goals. Deep expertise is necessary coupled with chemical ‘tricks’ which are not found in nature. Most significantly, if the work resembles real cells, at some point biochemicals deriving directly from cells are needed or must be manufactured with the help of cellular materials.

The example involves a 15-year project by the J. Craig Venter Institute, using a crack team of approximately 20 scientists headed by Nobel Laureate Hamilton Smith (chapters 1–5). The hype which accompanied the publication in 2010 of what they dubbed *Synthia* overlooked how nothing of relevance to support evolution was accomplished. In a nutshell, the DNA sequence of a living bacterium was duplicated synthetically, and then transferred into a living cell. This would be comparable to copying a program from one computer to a different one, and then giving the impression the entire system, including hardware and operating system, could have originated on its own.



How the DNA sequence was manufactured could be too technical for some readers, who may wish to skip to the next section. Others may benefit by reflecting on how origin-of-life researchers are forced to use intelligent strategies to overcome fundamental chemical realities which otherwise produce the wrong outcomes.

No serious researcher has attempted to design a collection of novel genes (and how to regulate them) in order to create an entirely new life-form. In fact, it is common knowledge that many indispensable genes exist, in even the simplest organisms, with currently unknown functions. Therefore, the target DNA sequence matched that of an already living organism *Mycoplasma mycoides* (*‘Myco’*) almost perfectly (p. 31).

What did the team do? The target genome was split into 1,078 consecutive segments called ‘cassettes’, each containing 1,080 base pairs (p. 33). Each cassette was divided into 15 to 20 fragments of DNA, called oligonucleotides (‘oligos’). To produce each oligo, the correct sequence of deoxynucleotides (*A*=adenine, *C*=cytosine, *G*=guanine or *T*=thymine) had to be linked together. Without the cellular molecular machines which perform

this linking task, Blue Heron, a company specialized in gene synthesis, had to apply some very sophisticated chemical tricks, as we will now see.

One difficulty is that the nucleotides possess several functional groups which can react together in alternative ways, all but one leading to the wrong product. To permit only the correct one to react, the others were rendered inert through chemical ‘blocking groups’. In addition, the -OH group which needed to react was activated by a special chemical substitution. These modified, fragile monomers were stored in the absence of water, air, and any impurities. Nothing like this will happen on its own in free nature.

One might be deceived into thinking that the work described so far at least involved chemicals obtained naturally, but often what is hidden under the rug is of greatest significance. It turns out that the four bonds located on some ‘chiral’ carbons of nucleotides can be arranged spatially in two manners, producing two isomers per chiral centre. These isomer pairs are mirror images of each other but are not super-imposable. There are three such ‘chiral centres’ in the nucleotides of DNA, leading to eight distinct isomers. Only one of these can be used to produce DNA and it must be 100% pure. The only way to obtain the correct single isomer requires using special enzymes found in living organisms (p. 36).

The discussion so far identifies important principles. Chemists are very clever people who know how to break down problems and manipulate conditions to attain intermediate goals, step by step. None of these learned skills nor techniques, however, have any relevance to naturalism, nor demonstrate godless evolution could work.

I will only highlight the next steps used by Venter’s team as they continued to synthesize *Synthia*’s DNA. Living *E. coli* with its sophisticated polymerase molecular machine was used to produce the cassettes, yeast cells were used to combine groups of 10 cassettes, and then these latter

intermediates were transferred back into *E. coli*.

Linking all the nucleotides using only thermal energy can only produce DNA chains a tiny fraction of a percent the necessary length, and without the accuracy necessary. Relying on complex biological molecular machines for this task illustrates once again the irrelevance of this otherwise interesting work to support evolution.

The resulting DNA sequence was still not precise enough to work due to an accidental overlooked single nucleotide deletion (p. 53) which had to be

corrected. Even that was not enough, as the team discovered that the synthesized DNA had to then receive a series of methyl group attachments. How could they know what would work? Evolutionary trial-and-error, perhaps? Certainly not.

Since the DNA needed to function in an organism very similar to *Myco*, called *Capri*, they carefully mimicked the methylation patterns used by both, and transferred the modified DNA into *Capri*. Both patterns worked. The ‘surrogate mother’ already had all the necessary proteins together

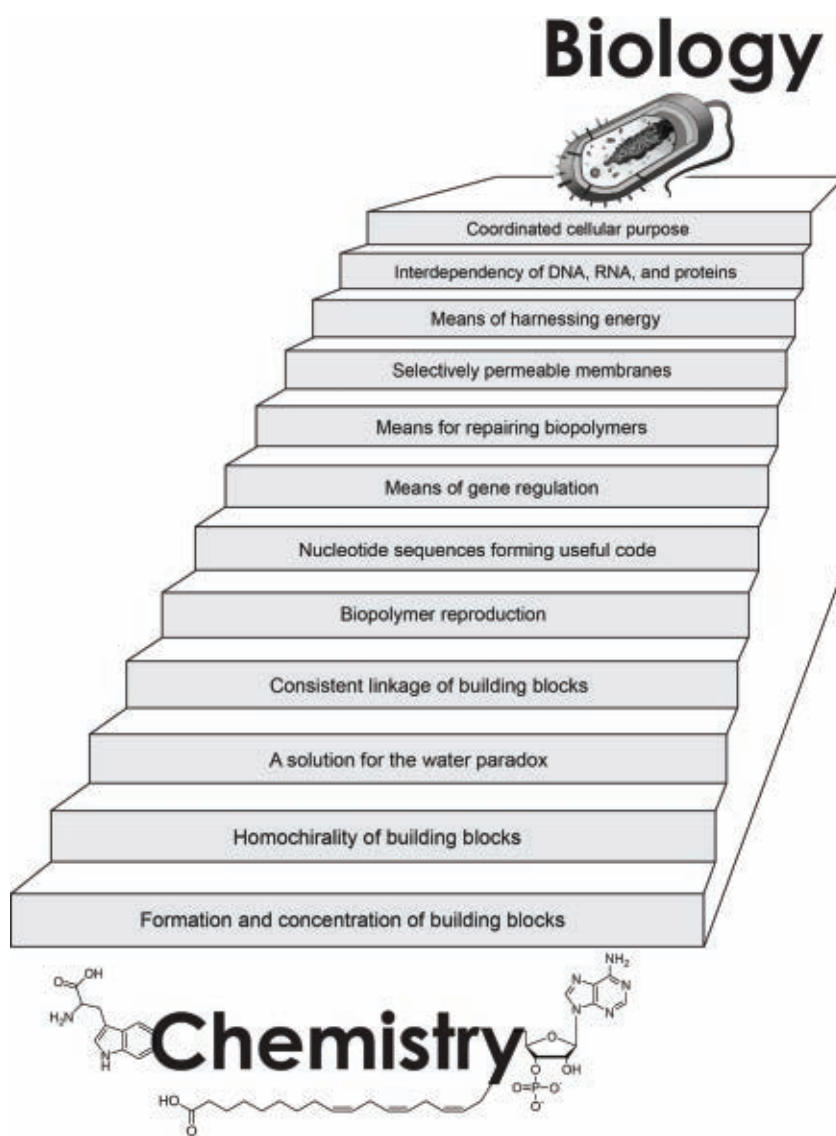


Figure 1. Summary of 12 unavoidable stages for a naturalist origin of cells

with assembled, working molecular machines in the right concentrations and locations, able to interact with the new DNA as expected.<sup>1</sup> The last step was to set up an artificial strategy of reproductive competition to remove the original *Capri* DNA from *Synthia*.

The *Synthia* example, which combined world-class top-down scientific design thinking plus all the key components from pre-existing living cells, prepares the reader's thinking for why naturalism fails badly in accounting for the origin of cells. A few highlights of each of the 12 stages will be offered next to drive this truth home, and to whet your appetite to read the full book (figure 1).

### Twelve unavoidable stages for a naturalist origin of cells

1. Formation and concentration of building blocks (chapter 7)

Those interested in reviewing prebiotic chemistry research may wish to also read the classic work by a team of creation scientists, *The Mystery of Life's Origin*.<sup>2</sup>

**Amino acids.** Unsurprising to an organic chemist, amino acids can form in small amounts under high-energy conditions using combinations of simpler molecules. The relevance to putative environments over four billion years ago is speculative, of course. The key issue is that other substances are also formed in vastly greater amounts. These can react with multiple functional groups of the amino acids, both preventing polymerization and damaging any polypeptide formed.

**Phospholipids.** Phospholipids are the raw material of cell membranes. Despite much effort, no one has succeeded in coming up with a construed environment with a single set of conditions able to bring together and produce large amounts of pure phosphates, glycerol, and appropriate long fatty acid chains. Remarkably, bacteria and archaea use very different

phospholipids, and thus have different enzymes to produce them. This is another of many facts arguing against all life having a common ancestor.

**Nucleotides.** Nucleotides consist of three parts: a nitrogenous base (*A, C, G, or T*), attached to a ribose sugar ring, and a phosphate group (figure 2). D-ribose exists in *five* isomeric forms (and two of those are more stable than the  $\beta$ -D-ribofuranose form used by DNA and RNA). Let us consider what happens when nucleotides polymerize, using adenine as a specific example. Any of the *four* -OH groups could react, and thus a phosphate group could react with any of the remaining *three* -OH groups. In addition, Adenine has *three* -NH locations which could bond to ribose (p. 79).

This leads to  $5 \times 4 \times 3 \times 3 = 180$  possible isomeric variants per adenine nucleotide, but only one is biologically correct (p. 80). Connecting 40 nucleotides like adenine into a chain would produce  $180^{40} = 1.6 \times 10^{90}$  alternatives, of which only one would be biologically correct. Recall that the smallest genomes of free-living organisms have over half a million nucleotides, not 40!

Tan and Stadler take into account chirality and the need for correct nucleotide sequences later, but other experts have included these aspects also in their own calculations, cementing how absurd it is to expect natural processes to produce DNA (and RNA):

- 3 sites on adenine
- × 5 sites on D-ribose
- × 8 pentoses
- × 3 sites left on pentose for phosphate links
- × 2 sites left on pentose for dinucleotide links
- × 3 considering that purines can form with the -NH<sub>2</sub> at C2, C8 as well as at the C6 positions for adenine.

The number of possible dinucleotides produced naturally is 2,160.<sup>3</sup> The true situation for evolutionists is therefore considerably worse than the calculation above showing  $1.6 \times 10^{90}$  alternatives for short chains of 40 adenines.

Given that a hypothetical RNA world is believed by many evolutionists to have preceded extant DNA-based life, much research has focused on forming ribose by polymerizing formaldehyde (the formose reaction). The desired ribose product, however, would be a minor component in a rich mixture of sugars and degrades rapidly compared to most of the other monosaccharides formed (p. 80).

All molecules needed to synthesize biomolecules must be concentrated at a suitable location but given the mish-mash of co-materials present would then end up producing a tar-like mixture. When we chemists react several organic substances together at a high temperature and do not carefully separate out the products and remaining reactants, we inevitably get a blackish amorphous sticky mess we call 'gunk'. (Which is often also foul smelling. No wonder so many otherwise normal students hate chemistry.) It takes careful planning, considerable expert know-how, practice, and long-term controlled conditions to isolate the relevant pure molecules needed.

**Many fundamental raw materials unavailable.** An issue not addressed by these authors which should be kept in mind is that under various primordial scenarios the essential simpler molecules needed will be destroyed. The abiogenesis stories told are along the lines of, 'Let's suppose everything were just so', but the alternative unavoidable facts are neglected.

To illustrate, UV light irradiation on Earth is believed to have been intense four billion years ago. Solar light of wavelength  $< 2000 \text{ \AA}$  would have caused methane to polymerize through free radical reactions and fall into the ocean as cross-linked hydrocarbons, probably covering the surface with an oil slick 1–10 metres deep. This would leave very little free methane in the atmosphere for other chemical purposes such as producing amino acids. In addition, a thick, viscous film covering the oceans would trap other organic



materials, preventing the kinds of reactions needed from occurring.

About 99% of the atmospheric formaldehyde, a key ingredient in proposed routes to synthesize nucleotides and other biomolecules, would have been quickly degraded to carbon monoxide and hydrogen also by photolysis. Carbon monoxide itself would have been quickly and irreversibly converted to formate in an alkaline ocean. Any ammonia present would have been rapidly photolyzed to (very inert) nitrogen and hydrogen. Hydrogen sulfide, essential to produce some amino acids in proposed chemical scenarios, would have been photolyzed to free sulfur and hydrogen. Furthermore, any hydrogen sulfide found in an ocean would have formed insoluble metal sulfides. Photodissociation of water would have produced oxygen, and even small amounts are deadly for the chemicals used in life.<sup>4</sup>

## 2. Homochirality of building blocks

Many biomolecules have one or more carbon centres with the property mentioned above called chirality. The mirror images of these centres are not superimposable, like the reflection of a pair of hands. The twin molecules are called *enantiomers*, and based on considerations of perfect symmetry, each pair is produced in exact 50:50

proportion (with a few extremely rare exceptions), called a *racemic mixture*. The isomers have identical physical properties such as melting and boiling point, so none of the laboratory nor natural ways to separate them work. Separation to obtain an “optically pure” single isomer sample is done by interactions with pre-existing biomolecules from cells, which come in only one of the enantiomeric forms.

Could events with equiprobable outcomes still show predominance of one or the other? From a fundamental principle of statistics, the Law of Big Numbers, the greater the number of trials the less likely this is to occur. And the number of biomolecules needed is vast. Furthermore, in the case of biochemical enantiomers, a bond at the chiral site can temporarily break, leading to a flat intermediate to which re-bonding can occur from either side. Bond-breaking and reforming to the alternative mirror image would occur more often for the predominant variant, relentlessly driving to a perfect mixture. In fact, measuring the loss of optical purity of L-amino acids is a means of dating how long ago an organism died.

Should an unknown principle be able to form one enantiomer preferentially, the more time transpires the more opportunities to equilibrate to

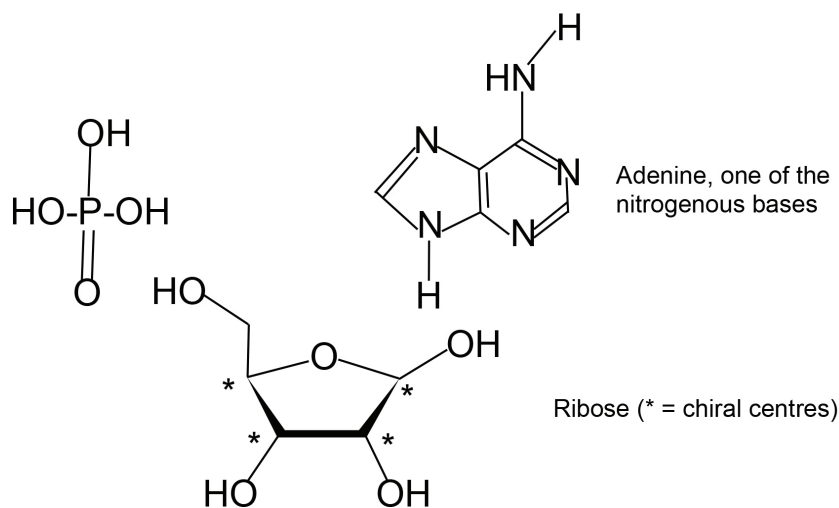
a perfect racemic mixture. And the increasing complexity assigned to evolution would require even more and larger optically pure building materials. Time is not the secret weapon of evolution!

The deoxyribose rings of DNA contain three chiral centres, and the RNA version has four, as shown in the figure above. The central carbon of amino acids has one such centre, and glycerol once integrated into phospholipids also have a chiral centre. This means that under natural conditions, reactions of simpler molecules leading to a chiral centre in the larger product molecule will generate a non-superimposable pair for every chiral carbon. But in living systems only one of the enantiomers must be selected to form proteins, DNA, RNA, and cell membranes, so that the final polymers can possess consistent three-dimensional structures.

The homochirality requirements are never met under natural conditions. This works in cells because the pure enantiomers are synthesized using pre-existing optically pure enzymes. And these come from, well, you know, pre-existing ... In addition, cells recycle most biomolecules continually, helping to eliminate any incorrect isomerization occurring after they were produced.

Although the need for *optically pure* biopolymer chains ranging from tens to millions of monomers long is well known, this unavoidable requirement is carefully overlooked in virtually all discussions of naturalistic abiogenesis.

Various attempts to circumvent the chirality problem are discussed in the book. In one case chemists artificially begin with a prevalence of one enantiomer and set up a construed autocatalytic reaction based on clever dialkylzinc chemistry having no chance of arising on its own (p. 92). Some mineral surfaces like quartz and calcite can have a minor preference for an enantiomer version of amino acids, up to 10% over a microscopic portion of the surface if the minerals are scrupulously



**Figure 2.** The three components of a nucleotide using adenine as an example

purified (p. 92). In all these attempts one must recall that even 99% purity would not be sufficient, and most importantly that racemizing to a 50:50 mixture just occurs over time anyway.

### 3. A solution for the water paradox

The polymerization reactions to produce DNA, RNA, proteins, and phospholipids generate a molecule of water per chemical bond formed. However, when dissolved in water, the reaction goes in the reverse direction, to generate the individual component monomers. Water will also deaminate the nucleobases cytosine and adenine, and lead to other undesirable reactions (p. 97). In view of these established realities it is puzzling why the notion of life having arisen in a primordial ocean has not been removed from science textbooks.

Nevertheless, a suitable solvent must be available if the monomers are to react outside of cells, along with a high local energy source. Given the contradictory requirements, naturalist scenarios require clever planning by chemists who separate and protect each component to prevent destructive pathways, bring the parts together in a judicious manner, and separate the products in just the right way. An example is the use of ferricyanide, hydrogen sulfide and pure, homochiral, activated amino acids (p. 96).

### 4. Consistent linkage of building blocks

Key biopolymers in life are huge. On average a protein consists of about 300 amino acid monomers, and the simplest free-living organism's DNA contains about half a million nucleotides (p. 103). Forming long 'homolinkage' chains does not occur in free nature for fundamental chemical and statistical reasons. Suppose the above requirements were met, and the correct enantiomers were produced and isolated in high concentration in one location without contamination from other competing chemicals. Alas, different functional groups on each

monomer (amino acid or nucleotide) can also react together, whereas only one is correct. This leads to a complex mixture known as the 'asphalt paradox' (p. 103).

The large biopolymers are viscous and very sticky. Long before attaining a relevant length under natural conditions they become hopelessly entangled, undergoing further internal reactions between nearby functional groups instead of only linear extensions by reacting at their ends.

### 5. Biopolymer reproduction

No biological life can exist without reproduction. But how are copies of DNA and RNA to be generated at all, far less reliably over millions of generations? Cells contain a collection of molecular machines to manufacture DNA, RNA, proteins, and phospholipids, and these machines consist of mainly proteins encoded on DNA. None of these manufacturing systems would be available prebiotically. Various attempts to resolve this have been carried out, but none limit themselves to components of non-biological origin. All attempts reflect a deep understanding of what sub-goals need to be met to achieve a target outcome, reflecting very clever organization and guidance. All results to date deepen our conviction that a super intelligence (God) designed cells from the very beginning.

### 6. Nucleotide sequences forming useful code

Even if it were possible to produce long polymers reliably this is far removed from anything with life-like features. Humans synthesize thousands of tons of plastics (which are also polymers) every year, but nobody confuses these with living organisms. Whether considering DNA as an information carrier or RNA as a source of catalysts for chemical reactions, relevant sequences of monomers must be linked together. The origin of information is a serious objection to mindless abiogenesis.

Proteins are key players, and all forms of life depend on them. Something would have had to guide the consistent reproduction of many copies of different groups of sequences. It is known that most random sequence amino acid chains serve no biological use.

### 7. Means of gene regulation

If all preceding steps were achieved, hundreds of RNA or DNA 'proto-genes' would now exist, contained either in one long polymer or split up among hundreds of shorter but still very long ones. Having supposedly arisen independently via natural selection these would compete, with those having shorter reproductive cycles outpopulating the others. But instead of producing only one or a few victors, the genes or living organisms must collaborate as a holistic entity.

Collections of genes must be regulated to avoid run-away production. The right number must be active at the right time and location. As far as scientists have determined, all processes in cells are regulated and in very precise ways. These involve three parts (p. 128): 1) A means of sensing; 2) a means of making decisions which are in the collective interest; and 3) a means of acting upon the decision.

Thousands of examples of feedback regulation are known, and the authors describe a few. *E. coli* manufactures a necessary amino acid called tryptophan using the enzyme tryptophan synthase. Producing this tryptophan consumes valuable material and energy, and run-away over-production would be deleterious. How is regulation accomplished? In the cell freely available tryptophan is involved in a negative feedback loop with tryptophan synthase. In this case, another gene is present which codes for a regulatory protein called 'TrpR', which can directly sense the presence of tryptophan, changing its shape (p. 129). The modified TrpR binds to a specific regulatory DNA sequence a short distance from the tryptophan synthase gene, deactivating it. Tryptophan is no longer manufactured.

The complete story was not elaborated on, but the general principle for this kind of regulation is that the regulatory proteins eventually disassociate from the cognate section of DNA. If the concentration of this protein is high, another one binds shortly afterwards, and the gene remains correctly inactivated. Otherwise the gene is unrepressed, causing more of the enzyme to be produced and thereby more of the protein identified as being in undersupply.

We notice here again the chicken-and-end dilemma found whenever we examine regulatory schemes. What came first, the biomolecular feature or its regulatory infrastructure? This is a guiding principle I kept noticing when reading standard university textbooks on cell biology and biochemistry. It should therefore come as no surprise that non-evolutionists have no misgivings about reading any of the leading works on epigenetics,<sup>5</sup> systems biology,<sup>6</sup> and biological circuits<sup>1</sup> even if written by evolutionists. The occasional lame allegations about the wondrous guidance provided by evolution always lack plausibility or any kind of evidence, add no insight to the discussion, and are best simply ignored as irrelevant wordiness.

Until a new biological process is working close to flawlessly it would have negative value, costing valuable energy and resources, and would slow down the rate of reproduction since more DNA must be duplicated. The cellular economic tradeoffs<sup>7</sup> of carrying incompletely developed features can be analyzed mathematically.<sup>8</sup>

#### 8. Means for repairing biopolymers

The vast amount of information carried on DNA and RNA needs to be maintained over time. Tan and Stadler describe some sophisticated DNA repair mechanisms which counteract several ways DNA is destroyed during an organism's lifetime in order to ensure its long-term viability (chapter 14). As one would expect, the repair processes are also coded for on DNA.

Where would all this extra DNA come from, needed to eventually code for dozens of new genes? Evolutionists face the inevitable chicken-and-egg problem once more, being unwilling to accept that cells with their subsystems were designed as integrated entities from the beginning.

There is a strange notion that deep time would allow the accumulation of innumerable chunks of information. The necessary sequences are assumed to have been shorter initially, in order to ameliorate the staggering improbabilities involved. But the reality is that the physical carriers would be corrupted both during their lifetimes and for every replication cycle.

In addition, Nobel Laureate Manfred Eigen pointed out in 1971 that a prebiotic molecule like RNA could not have been very long because of the error rate during replication (p. 139). Longer polymers would introduce more errors, leading to error catastrophe. The obvious implication is that error-correcting genes could not have been added to the genome by random processes.

#### 9. Selectively permeable membranes

Functional membranes are necessary for cells to be viable. A continuous supply of building materials and energy must be supplied from the external environment and concurrently waste products must be removed. This careful logistical control is so demanding that

about a third of known proteins function within membranes (p. 143).

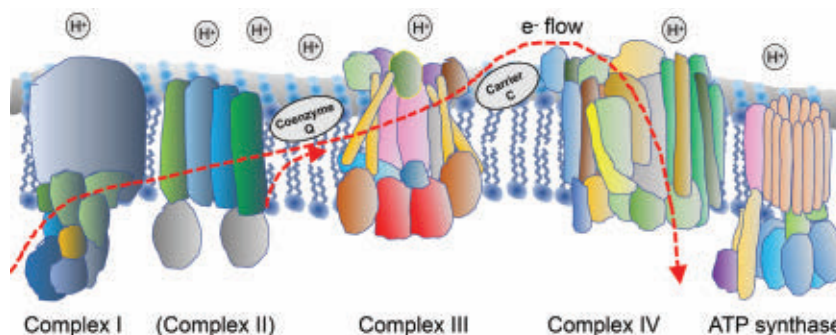
Pores are specialized complexes of multiple proteins working together to allow specific kinds of molecules to traverse membranes. New, evolving pores would function inappropriately leading to 'holes' and thereby deadly leakage. The proteins used by pores require special chemical properties not only to recognize their target substances but also to ensure their correct spatial location. Most pores require energy to function, provided in a carefully regulated manner (ATP molecules).

Membranes and their accompanying proteins are replicated and provided as a functional entity to new daughter cells (p. 147).

#### 10. Means of harnessing energy

Cellular processes require a large amount of energy, provided in a carefully regulated manner. Sources of energy like direct blasts of UV light or high temperatures would destroy the key biochemicals. The process for harnessing and storing energy in organisms is known as 'chemiosmotic coupling' (p. 150). Raw energy sources include sunlight, larger organic molecules, and some inorganic simple chemicals.

The *Electron Transport Chain* (figure 3) is how energy is extracted from food to produce a proton gradient across a membrane (except for methanogens and acetogens, which use different, unrelated mechanisms).



**Figure 3.** Complex I, III and IV of the Electron Transfer Chain linked to ATP synthase. This diagram shows Complex II which is found in *E. coli* and other organisms. The number of proteins in each complex varies in different classes of organisms.



A sequence of about 15 reactions are linked sequentially to strip energy from carbon-containing biomolecules. This involves three protein-based complexes (*NADH-Q Oxidoreductase*, *coenzyme Q-cytochrome c oxidoreductase*, and *cytochrome c oxidase*). Between 25 and 69 proteins are needed, depending on the kind of organism (p. 155). Working together with an efficiency unmatched by human technology, each pair of electrons provides the energy necessary to pump 10 protons across the membrane.

On the other side of the membrane lies a generator called *ATP Synthase*. An excellent animation can be viewed on YouTube.<sup>9</sup> The simplest kind known (in *E. coli*) requires at least 20 interconnected proteins (p. 155). This machine consumes 10 protons per three molecules of high-energy ATP molecules formed from adenosine diphosphate (ADP). ATP can then attach to carefully prepared parts of biomolecules to provide a standardized energy packet through hydrolyzation back to ADP.

Virtually everything occurring in a cell besides random diffusion requires ATP. Examples include DNA replication, disentangling DNA, charging tRNAs, translation of the genetic code, and cell replication.

#### 11. Interdependency of DNA, RNA, and proteins

Cells require mutual collaboration between three classes of biochemicals: DNA, RNA, and proteins. The protein sequences are specified by mRNAs, which themselves are derived from DNA. Specification is not enough; the rules must be implemented, and more than 48 proteins are needed by ribosomes to carry out the translation process.

However, DNA and RNA are created from nucleotides themselves catalyzed by protein-based enzymes. Transcription of DNA to RNA requires RNA polymerases, which are mostly protein complexes, and replication of DNA requires DNA polymerases, which are also protein-based complexes of at least 14 enzymes (p. 163). There

are many more examples of necessary processes DNA and RNA undergo which depend on proteins. Clearly the equipment based on DNA, RNA, and proteins must be present concurrently for a cell to be viable.

The attempt to simplify led to the poorly thought-out RNA world hypothesis. A single intractable problem was replaced by two intractable problems. Nothing has been gained for the evolutionist. The first problem involves producing an RNA form of life, very problematic given the poverty of chemical features these could offer compared to proteins.

The second problem involves transforming an RNA form of life to what we see today. A valuable insight is that there is no physical template-like relationship between RNA and functional equivalent protein sequences. The genetic code, a purely logical construct, maps the two kinds of sequences. If RNA complexes had been able to perform the tasks executed by current proteins, there is no path to convert one into the other. The extant system, based on no relationship with a putative ancestral invention would still need to be created, with all the mutually necessary subsystems using RNA, DNA, proteins, and phospholipids. Additional new requirements include needing a reliable source of ATP immediately, protein-based pores, proteins to compact DNA (p. 169), the protein-based machinery to duplicate the new cells, and so on.

#### 12. Coordinated cellular purpose

A cell is far more than a vast organic molecular soup. If we sterilize a cell and then observe what happens, it does not suddenly act life-like (p. 171). But when a daughter cell is produced with the same components interacting correctly from the very beginning, it can then continue living on its own. Therefore no competent research team would seriously consider creating a living cell by synthesizing various molecules in the right proportions and then simply mixing them together.

Cells consist of layers of organization, with coordinated activity and crosstalk between processes in an orchestrated manner. Cells are not static and can react dynamically to external signals and current needs. But this adaptive behaviour is carefully regulated to prevent chaos. It is necessary for a multitude of individual processes to execute in a repeatable and sustainable manner at the same time from the very start.

The authors had the goal to show how:

“... every atheist, by definition, must believe that purely natural processes could surmount every step on the Stairway to Life ... . One purpose of this book is to call out and clarify the leap of faith that atheism implies” (p. 185).

At each of these 12 steps an objective scientist should realize that the outcome is not what we expect to occur from chemistry nor physics acting with no intelligent input.

This book belongs on the bookshelf, computer, or smartphone of all serious evolutionists and non-evolutionists.

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# The evolutionary icon of useless organs has crumbled

## ***Useless Organs: The rise and fall of a central claim of evolution***

Jerry Bergman

BP Books, Tulsa, OK, 2019

John Woodmorappe

The argument about the human body being full of vestigial organs is over a century old. It is a dysteleological one. It allegedly points to organisms having an evolutionary history, as shown by the ‘fact’ that these certain organs were once functional, but no longer are. It otherwise accuses the Creator of making organisms with non-functional organs.

The vestigial organ argument is not passé. It is still very much part of evolutionary orthodoxy. Bergman (pp. 18–19) cites the study of Skoog, who evaluated 93 representative secondary biology textbooks from 1900 to 1977. A total of 9,641 words were devoted to the vestigial organ argument!

The author, Jerry Bergman, is a scientist with a background in medical research. He has nine academic degrees, including five masters and two Ph.Ds. He has over 1,300 publications in scientific journals. The present work discusses many so-called vestigial organs, and I focus on some of the better-known ones.

### **The appendix**

The appendix (figure 1) has been the showcase of an evolutionary vestigial organ since the days of Darwin. It has since been repeated *ad nauseum*

in textbooks. In recent years, atheistic biologist Jerry Coyne has used vestigial organs to ‘beat up’ creationists. He goes on and on about all the ‘bad design’ in the human body, including the appendix (p. 13).

Not so fast. Coyne’s outburst of evolutionary triumphalism is seriously misplaced. The appendix is hardly useless. It is now known to have an immune function (p. 55), and, during early development, it serves as a lymphoid organ (p. 59). The innervation of the appendix had been little studied because of its presumed lack of function (p. 56). Now the appendix is known to be a reservoir of beneficial intestinal bacteria.

### **Evolutionary imagination and the human embryo**

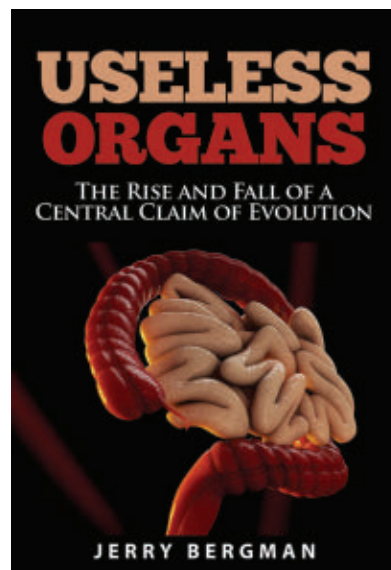
Human embryos temporarily have what superficially looks like a tail. However, there is no evidence that this is anything more than the way the spine develops relative to the rest of the trunk.

Evidence from embryology is always subject to interpretation. For instance, no one suggests that the cleft palate or Siamese twins are manifestations of throwbacks to an evolutionarily ancestral condition!

The ‘human tail’ does not even make sense phylogenetically. Bergman points out that our supposedly nearest relatives—chimps, bonobos, gorillas, orangutans, and other apes—lack tails.

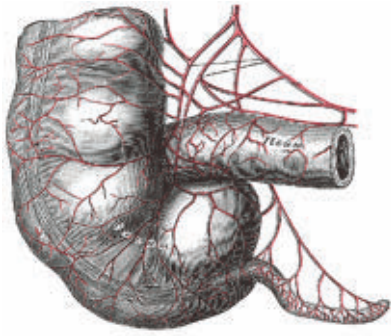
Now consider those immortal gill slits. Though they are brought up from time to time, their existence is totally imaginary. Bergman pointedly writes:

“The gill and gill slit claims are not only totally false, but were recognized as erroneous as early as 1868.



This fact is now acknowledged by many authorities, such as a 2001 text by Hickman *et al.*, which admitted that, ‘the gill arches serve no respiratory function in either embryos or adults ...’. O’Rahilly and Muller plainly state that ‘the pharyngeal clefts of vertebrate embryos ... are neither gills nor slits.’ Blechschmidt is even more forceful, concluding that ‘the so-called basic law of biogenetics is wrong. No buts or ifs can mitigate this fact.’ He adds that the gill stage myth is ‘not even a tiny bit correct or correct in a different form ... . It is totally wrong.’ This view is now universally shared by mainstream embryologists” (p. 96).

Now consider downy hair (laguno). The unborn human is covered by this fine hair, and evolutionists have seized upon this as an evolutionary throwback to the alleged hairy ancestors of humans. Now, if hair covering had only a thermoregulatory function, its presence on the unborn child in the uterus would make no sense, as the temperature in the womb is warm and uniform. But hair has multiple functions. In the case of laguno, it indirectly helps protect the skin of the embryo from the hostile watery womb environment.



**Figure 1.** The appendix, no longer a useless organ

### **The thyroid—believe it or not—was once believed to be a vestigial organ**

Bergman recounts the work of creationist surgeon and medical researcher Emil Theodor Kocher (1841–1917). Kocher, a pioneer active at the time of Darwin, rejected the ruling paradigm which taught that the body is full of useless evolutionary leftovers. Inspired by his creationist beliefs (he was a member of the Moravian Church), Kocher tested them. He transplanted thyroid tissue into patients that had undergone thyroidectomy. In time, he was shown to be correct about the function of the thyroid gland, and was awarded the Nobel Prize in 1909—the first Swiss citizen to receive one.

### **Even on its own terms, evolution cannot explain the origins of vestigial organs**

It turns out that vestigial organs, even if they existed, are just as much a problem for evolutionary theory as they putatively are for creationism. The essential notion of an organ losing its function and becoming vestigial is tacitly Lamarckian. It assumes that an organ that is no longer used is somehow receptive to shrinkage and eventual disappearance. Bergman shows that this is problematic. If an organism has lost its function, there is no obvious

selective advantage to have it reduced or removed.

### **Surgical removal of ‘vestigial’ organs does in fact harm the host organism**

It has long been supposed that the removal of ‘vestigial’ organs does no harm to the organism. Even if this was so, it would not prove that the organ was functionless. It would only prove that it did not have an *essential* function. This would be consistent with *designed* redundancy, which engineers often build into machines.

As it turns out, close examination shows that removal of ‘vestigial’ organs does in fact harm the organism, even if the harm is not immediately apparent. Jerry Bergman points out that removal of the appendix is now known to be associated with maladies such as Hodgkin’s disease, leukemia, colon and ovarian cancer, and Crohn’s disease (pp. 70–71).

In like manner, removal of the tonsils increases the risk of Crohn’s disease (p. 70). It also increases the likelihood of Hodgkin’s disease by a factor of three (p. 83). Now consider the once-widespread removal of the ‘useless’ tonsils. A detailed study showed that those with tonsillectomies had three times the risk of asthma and twice the risk of chronic bronchitis, emphysema, upper respiratory tract diseases, and conjunctivitis (p. 86).

Let us also consider the thymus gland. The thymus gland starts to disappear at puberty, so was long thought useless. But if removed early in life, the immune system fails to develop properly (p. 249).

### **Modern civilization, and not ‘bad design’, causes problems with ‘vestigial’ organs**

The relative smallness of jaws that cause problems with wisdom teeth, instead of being caused by recent evolution (which Bergman finds

independently unconvincing) may instead be caused by diet. The soft, processed foods eaten nowadays do not facilitate growth of the jaw to its natural size (p. 186). This is also borne out by the fact that problems with wisdom teeth are rare in primitive societies (p. 191).

Now consider appendicitis. Instead of pointing to a useless and often harmful organ, it may result from living in an overly hygienic society, leading to overreaction of the immune system (p. 57). It is also far less frequent in cultures with a high-fibre diet. Some researchers believe premodern man seldom had problems with appendicitis (p. 62).

### **Far from advancing science, evolutionary theory set back medical science**

Evolutionary theory is often touted as the very cornerstone of biological science. Bergman shows how it was often the exact opposite. Evolutionary thinking led to widespread medical policies that were, at best, unnecessary, and which, at worst, diverted attention away from legitimate medical concerns.

The appendix used to be removed as a matter of course when the abdomen was opened for some other surgery. (My grandmother, who had surgery for liver cancer, had this experience.) As noted earlier, the appendix is now known to have several functions.

Tonsillectomies used to be routinely done on children. Author Bergman had his tonsils removed as a child. Now we know better.

It is argued that science has advanced. Yes, it has, but was it because of evolutionary theory or was it *in spite of it*? One must ask a more fundamental question: could all the needless appendectomies and tonsillectomies have been avoided had we not subscribed to the preconceptions of non-functionality imposed by evolutionary theory?



### Evolutionists backpedal and change their argument

In the face of undeniable evidence that so-called ‘vestigial’ organs have a function, the evolutionists have ‘moved the goalposts’. Instead of saying that vestigial organs have no function, they now tell us that they have a *reduced* function. Jerry Bergman calls them out on their subterfuge. To begin with, they have changed their argument. Theirs is a retreat from their no-function claim, and an attempt to surreptitiously substitute a reduced-function claim.

Bergman points out that, outside of assuming a common evolutionary origin of organs, there is no way of knowing what is or is not a ‘reduced’ function. For instance, to say that a human appendix, as a reservoir of gut bacteria, has a reduced function compared with the digestive function of the appendix in the rabbit is to hold up the rabbit appendix as the ‘true’ or ‘complete’ functional modality to which the human appendix must be compared.

In other words, the ‘reduced function’ argument does not prove evolution. It *assumes* evolution in the first place.

### Conclusions

‘Vestigial’ organs are one of the icons of evolution, as per Jonathan Wells. Jerry Bergman’s iconoclasm sets the record straight. Though vestigial organs live on as textbook orthodoxy, there is no compelling evidence of purposeless organs in the human body.

## Homo lapsus—another failed theodicy

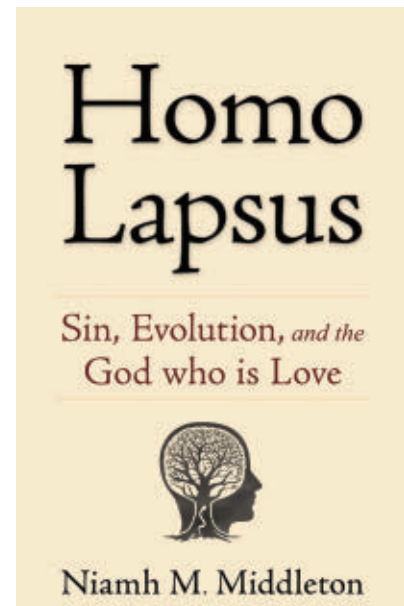
*Homo Lapsus: Sin, evolution and the God who is love*

Niamh M. Middleton  
Deep River Books, 2018

Philip B. Bell

The Irish author of this intriguingly titled book lectures in theology at Dublin City University. *Homo Lapsus* is her first book, but well-known Darwinist and professor in philosophy of biology Michael Ruse is impressed, calling it “a deeply informed and sympathetic attempt to reconcile modern evolutionary thinking with central Christian belief ... one of the best-written and enjoyable academic books I have read in some time.”<sup>1</sup> Certainly, Middleton writes engagingly, but her thesis is nothing if not audacious. It purports to be a satisfying synthesis between Christianity and evolutionary theory, explaining the origin of both evil and goodness, while also providing empirical evidence that corroborates the Genesis story as a higher form of revelation than science itself! This reviewer can testify that, indeed, this is a novel theistic evolutionary approach.

While the author evidences extensive reading, her lack of competency in biology shows itself in several places. For instance, she generally fails to italicize genus and species names (e.g. p. 106), confuses *Evo Devo* with epigenetics (p. 45),<sup>2</sup> incorrectly defines genetic drift (p. 63), completely misunderstands diploid (p. 84), and repeats out-of-date claims concerning the percent similarity of human versus chimp



DNA (pp. 68, 105). She also uncritically accepts the idea that natural selection is “a unifying force throughout every field of biology” (p. 67), perhaps unaware that many eminent biologists disagree.<sup>3,4</sup> Nevertheless, it would be churlish to judge her main thesis on these shortcomings.

### Absolving God of evil?

Middleton’s attempt to develop a new theodicy begins in earnest in chapter 3. She acknowledges that many early advocates of, and protagonists for, evolution thought atheism was a natural corollary of such an unpleasant process: “Nietzsche and Freud ... were undiluted Darwinists who ... immediately grasped the nihilistic implications of Darwinism” (pp. 40–41). To what extent human nature is determined by genetics is a critical question but, wanting to retain a beneficent God, she tries

to reassure readers that genetic determinism need not lead to atheism.

The author does admit, though, that many attempted syntheses of evolution and Christian religion do away with the doctrine of salvation and undermine the idea of an all-good God. How, then, to get the ‘evolver god’ off the hook, to absolve him from the charge that he authored evil? A critical component of her own theodicy is that evil itself evolved:

“A certain degree of aggression, selfishness, and competitiveness would have had to evolve and become part of human psychology for the species to survive, thrive, and, from a theological perspective, for virtue to be possible ...” (p. 85).

All theistic evolutionary ideas of ‘moral evolution’ are troubling, however, and this one is no different. Her proposition is also entirely alien to the cut and thrust of biblical teaching on the subject. Nevertheless, Middleton freely speculates on what might have occurred at the outset of human evolution. After a seemingly irrelevant excursus about bonobos as a peaceable and sexually active species,<sup>5</sup> it then becomes clear that she sees them as a window onto our early ancestors. Concerning this “gentler species” at the dawn of human evolution, she says:

“I would argue that they possessed a power and freedom of the will that is denied to us, their descendants. ... what is certain is that morally speaking, the will of the first humans would have been freer than ours. Human nature was new, fluid and untainted” (p. 103).

Middleton is not the first author to entertain similar ideas of ‘original goodness’,<sup>6</sup> minimising both human moral accountability to their Creator and His repugnance at human sin. She recognises that language, creativity, and the use of symbolism are human capacities, so did God intervene to spark these off? No, supposedly these human traits were divinely instilled during

vast ages of time. Only much later did God intervene to transform an anatomically modern *Homo sapiens* into a true human being:

“I would surmise that it was between the evolution of *Homo erectus* and the appearance of the first cognitively modern humans that the basis for what we like to call common human decency was laid down. ... In explicitly religious terms, this would mean that God infused a spiritual soul into a pre-existing hominid species” (pp. 141, 142).

In spite of these hominids having evolved—presumably by ‘survival of the fittest’—we are assured that this “lovable and attractive species” (p. 147) had not yet learned aggression and treachery.

### An evolving moral decline

The author’s speculations about moral evolution are piled high in chapter 5 as she goes on to ‘explain’ how our ancestors gradually and increasingly lapsed from this gloriously naïve condition. But it is hardly “Paradise Lost”, in spite of her chapter title. Like many such writers, she liberally

uses the language of make-believe: “it would have”, “perhaps”, “Let us suppose”, “imagine”, “somehow”, “I will argue”, “my belief that”, “we will now speculate”, “It is my opinion”, “I would go so far as to argue”, “one possibility”, “would no doubt”, “would undoubtedly have occurred”, “must have been”, “may have been”, “it can easily be imagined”, “we can say with some degree of certainty”, and so on *ad nauseam*. For example:

“The problem is that the natural competitiveness of our species *somehow* attained a ruthless ferocity to the extent that a significant proportion of any human grouping is now capable of practiced deception, exploitation, cruelty, corruption, and even parasitism to attain wealth, power and prestige. ... this evolutionary pathway *could only have* been taken through deliberate, repeated, hardening of hearts that *would have* led to a change in tribal culture ... [emphases added]” (pp. 156–157).

Original sin, the violation of the Creator’s words, is substituted with the evolution of hardened hearts. No, really; “the genes of the harder-hearted and more deceitful ... would have begun



**Figure 1.** The word ‘theodicy’ was coined by German polymath Gottfried Leibniz (1646–1716) as an attempt to reconcile natural ‘evils’ with the existence of a beneficent God.

to increase exponentially ... Unfortunately ... the genes of the treacherous, once their numbers had reached a certain threshold, would have spread with alacrity” (pp. 158–159).

Let me remind readers of this review that Michael Ruse considers this book “deeply informed”—but informed by what? Certainly not by any actual discoveries in the field of genetics! The author does not concern herself about scientific details, yet those are what matter if evolutionary theorising is to even masquerade as science. How, for instance, might we set about testing her confident assertion that the “coevolution of genes and culture explains the entrenched human desire for and admiration of wealth, status and prestige” (p. 170)? With mesmerising self-confidence, Middleton believes her piled-high speculations have solved the riddle where so many other theistic evolutionists have failed:

“It may be concluded, therefore, that evolutionary biology and its associated disciplines clarify the causes of evil in such a way that they lay the groundwork for empirical corroboration of theism. ... The main barrier to a possible synthesis of the [Darwinian and Christian accounts of human nature] has been the apparently inevitable evolution of evil. This challenge has now been dealt with” (p. 189).

Such a claim, though, is quite baseless, notwithstanding the author’s certitude. Middleton tries very hard to accommodate her ideas of human evolution within the Genesis account, but it is a futile exercise. *If only* our ancestors had been prepared to sacrifice self-interest for the interests of the tribal group:

“Eventually tribes would have merged into peoples, and humanity would have evolved into a peaceful, kindly, and compassionate species, without war, poverty, or unjust inequalities. Instead, *Homo*

*sapiens* also became *Homo lapsus*” (pp. 214–215).

Well into the last third of the book, this is the first mention of its main title, *Homo Lapsus*. In other words, ‘original sin’ was really just the failure of our ancestors to pursue what evolutionists call reciprocal altruism—*this* was their “primal act of disobedience” (p. 213). Middleton asserts that “Adam and Eve are better envisaged as, in one sense, the first group leader and his wife”, citing American Old Testament scholar C. John Collins in support of her contention.<sup>7</sup> She does not envisage that the consequences of their moral decisions violated a divine interdiction, rather that they impacted the human gene pool (p. 216).

### A wretched gospel

Middleton does recognise that to objectively talk of good and evil is not possible within a wholly secular evolutionary context, where morality would be relative. To talk in terms of *better* or *worse* with respect to moral decisions, one must accept a moral Lawgiver. She knows this, but her discombobulations get the better of her. She believes serious evil itself evolved, although this

was not inevitable. Nevertheless, it had to be due to the *free* choices of her ‘Adam and Eve’. She concedes that her “hypothesis ... would be pointless were it not for the biblical revelation of an all-good, all-powerful God” (p. 234).

Sadly, while we can concede that the author has good intentions, her attempts to reconcile evolution with God lead her into ever deeper violations of Christian doctrine. We read that the Apostle Paul invented the idea of original sin, where “Adam had passed on his sin to all of humanity, and Jesus, ‘the second [sic—*last*] Adam,’ had to atone for Adam’s sin” (p. 195). Allegedly, Paul’s reason for this concoction was to save the early Christians from the embarrassment of having to explain why Jesus was crucified (which she presumably sees as a tragedy). At least she accepts that original sin is a genuinely Pauline doctrine. On this key component of soteriology, however, she favours Thomas Aquinas over Martin Luther, finding Luther’s definition of sin (as a deliberate and settled rejection of God) too pessimistic!

When such counter-biblical reasoning is left unchecked in a person’s



**Figure 2.** Middleton’s imaginative theodicy redefines sin, hitting the very foundation of the Christian Gospel.



mind, it can sound the death knell of true faith; it is antithetical to the pure message of the Christian Gospel. Yet, this is not to deny that Middleton has a faith of sorts, rather that her theology is far removed from that of evangelicalism. Having quoted the sublime words of Psalm 8:4–9, concerning the condescension of God in so elevating a creature (man) as to bear His image, she immediately states:

“Most of all, science reveals the *basic goodness* of human nature itself, made good over millions of years of evolution ... No matter what decisions our forebears made or might have made, there is a *fundamental goodness* to human nature ... that is prior to any free moral decision; this *pre-moral goodness* with its associated behaviors and behavioral patterns cannot be eliminated” (p. 241).

Premoral behaviours include “immense courage, resilience, and self-discipline” (p. 265), traits which allegedly had evolved long before people became ‘fallen’. This basic goodness is a theme to which she often returns, apparently desperate to convince both herself and her readers of its veracity. It is, nonetheless, a travesty of Christian hamartiology. It is the root of what equates to a denial of the Gospel itself. Tragically, such baloney should come as little surprise if one reflects upon her title for chapter 7 (pp. 229–258): “Consilience: the exhilarating god of natural selection”. The rejoinder, that this is not the God of the Bible, would surely win the ‘litotes prize’.

### Theological chaos

With all attempts to find an accommodation between the Bible and the evolutionary machinations of so-called science, it is the latter which inevitably takes the exalted, hallowed position in the minds of the proponents. British geneticist Denis Alexander illustrated this when he wrote: “How do

we understand the Fall in the light of evolution?”<sup>8</sup> Evolutionary philosophising trumps biblical theology. So here, Middleton believes she has vindicated her “book’s central argument, which is that *the fall* of the first humans is best understood as a primal moral choice, or sequence of choices, that *had a damaging impact on the process of evolution* [emphases added]” (p. 250), an outlandish claim that she more-or-less repeats on p. 260. So what does salvation look like within this framework?

“Much of what would have been considered ‘sin’ in the past can now be attributed to circumstances that are not the fault of any particular individual and can, in fact, be *remedied through secular rather than religious means* [emphasis added]” (p. 261).

This bears no resemblance to Christianity—it is another gospel, eviscerated of any need for redemption through the sacrificial death of Jesus Christ. Instead, we must rely on our own efforts at moral rectitude (p. 268). Calvary is not in view. To cap it all, after quoting Isaiah 25:6–8—God providing His people with a rich feast, then wiping away tears from all faces—Middleton makes the asinine statement that:

“... the powerful emphasis of the whole Judeo-Christian tradition on hospitality and table fellowship resonates with the millions of years of evolution that embedded the love of such pleasures in human nature” (pp. 271–272).

She opines that human beings themselves might have created an earthly paradise of comfort, ease, and plenty (which she says was willed by God). Instead, she laments, evolving evils have wreaked havoc on peoples, societies, and nations. While acknowledging that the realisation of Isaiah’s vision would necessitate an end to all conflict and a restoration of peace between humans globally, her subsequent theological discussion (which also takes in the Last

Supper) is way off beam—as is her ‘exposition’ of Jesus’ teaching in Matthew 10:34–39.

In conclusion, *Homo Lapsus* combines highly imaginative, pseudoscientific speculations, and topsy-turvy theology. Believing that most people have thrown off the old superstitions of fundamentalist Christianity, the author hopes her book might catalyse inter-religious dialogue to bring humanity closer to God. With respect, there is fat chance of that happening.

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1. From the back cover.
2. Evo Devo is shorthand for Evolutionary Developmental Biology.
3. ReMine, W.J., Desperate attempts to discover ‘the elusive process of evolution’; a review of *The Altenberg 16: An exposé of the evolution industry* by Suzan Mazur, 2010; *J. Creation* 26(1):24–30, 2012.
4. Mazur, S., *The Paradigm Shifters: Overthrowing ‘the hegemony of the culture of Darwin’*, Caswell Books, 2015. In this book, Susan Mazur interviews 19 scientists, some of whom are acknowledged world leaders in their fields, e.g. Carl Woese (1928–2012, microbiology; he revolutionised the field of phylogenetic taxonomy), Eugene Koonin (evolutionary and computational biology), and James Shapiro (bacterial genetics).
5. Sometimes termed pygmy chimpanzees, *Pan paniscus* are more gracile than *Pan troglodytes*, the more commonly known chimpanzees.
6. See chapter 7 of: Bell, P., *Evolution and the Christian Faith: Theistic evolution in the light of Scripture*, Day One Publications, pp. 146–169, 2018.
7. This appears in a long footnote on p. 217 of *Homo Lapsus*. Collins, she writes, “favors the idea of Adam and Eve being the first king and queen of a first tribe”. Collins, C.J., *Did Adam and Eve Really Exist? Who they were and why it matters*, Inter-Varsity Press, 2011.
8. See: Anderson, D., Viva la Evolution? A response to Denis Alexander, [creation.com/viva-la-evolution](http://creation.com/viva-la-evolution), 3 September 2008.

## Rapid growth of caves and speleothems

According to Michael Oard's article "Rapid growth of caves and speleothems: part 1—The excavation of the cave",<sup>1</sup> some secular scientists now realize that dissolution by carbonic acid is not a sufficient mechanism by which to explain the formation of the limestone caves we see. He explained several problems with this model. Those who recognize the limitations of the carbonic acid model are favouring a hypogenic (solution source located below the cave) sulfuric acid model of dissolution. There is evidence for such a process in some caves. For caves without such evidence, Palmer has written that "invading surface water tends to overwhelm the deep-seated process, or to modify the caves so that their pre-existing hypogenic features are masked".<sup>2</sup> Oard seems to embrace this sulfuric acid model, except he believes the acid came from the floodwaters above, and his explanation for the lack of evidence is that "the dissolution products of sulfuric acid ... could quite easily have been washed out during Flood drainage".<sup>3</sup>

I personally believe that neither carbonic acid nor sulfuric acid dissolution alone, or together, would have been sufficient to produce the caves we see. Tectonic forces could have produced and enlarged fractures considerably, according to Palmer.<sup>4</sup> Once such enlarging fractures reached the surface of the Flood-covered strata, I believe water would have been drawn in by suction at a prodigious rate, resulting in rapid cavitation and erosion, producing, in some cases, the tremendous cave passages we see in such places as Mammoth Cave, in Kentucky (figure 1); Hang Son Doong, in Viet Nam; and Deer Cave, in Borneo. This

suction is the same phenomenon that may be seen by squeezing the bulb of a medicine dropper, placing it under water, then releasing the bulb. As the volume inside the dropper increases, water rapidly enters the bulb. However, a bulb that has not been squeezed, if put under water and not released while under water will allow no water to enter it. I believe that this suction action is the reason that we see evidence of rapid flow in caves that have only one entrance to the outside. Oard referred to such rapid flow with statements such as "*high-speed flow* of acidic water is shown by the large amounts of gravel, cobbles, and boulders, not of carbonate, that are found in many caves [emphasis added]"<sup>3</sup> and "the chemical-rich water from the Flood would have *raced* through the joints, faults, and weaknesses in the bedding planes, rapidly dissolving the limestone and creating caves [emphasis added]".<sup>3</sup> I believe the effect here would not have been just rapid dissolution; but also rapid erosion, the two processes working together. The rapidity of the moving water would have greatly magnified the rate of dissolution by acid, as the products of the reactions would have been quickly removed. This would not have left much in the way of evidence for sulfuric acid dissolution. Once more, Oard stated: "Excavation was so rapid that the caves were already formed before

the end of the planning event of the Abative Phase."<sup>3</sup>

The case for the inadequacy of the carbonic acid model has been made by secular speleologists. But they have certainly not embraced the Flood model. They have found another model, which they believe has allowed them to maintain their faith in uniformitarianism. Our task now is to demonstrate the inadequacy of the sulfuric acid model, so that it will become evident that these caves could not have been formed just by slow, gradual, dissolution over immense spans of time; but must have also been the result of massive, rapid erosion. I suppose that there have been studies of the dissolution rates of limestone in sulfuric acid. How long would it have taken to have formed the Big Room at Carlsbad Cavern by sulfuric acid alone, without erosion? What problems would there have been with this scenario? It seems to me that all significant enlargement by slow, gradual dissolution alone would have ceased long before such rooms would have enlarged to their present enormous sizes. This would have been due to the products of dissolution (gypsum forming on the walls) interfering with the acid-limestone reactions. Another limiting factor would have been the dilution of the acid as it was used up in reacting and also by meteoric water. In addition, if one assumes a uniform rate of input of sulfuric acid solution into a room, and a uniform rate of output,



Figure 1. Rotunda Room, Mammoth Cave National Park, Kentucky

then, as the room enlarged, the water would have no longer been able to fill the rooms, resulting in a decrease of dissolution. Otherwise, as the room enlarged, in order for it to remain filled with water, the rate of flow would have to have increased. Yet, for these rooms that are now filled primarily with air, the rate has definitely decreased.

Oard stated that “during the Recessional Stage there was widespread uplift, which was also a massive erosional event on the surface of the continents”.<sup>3</sup> This can be seen by many erosional features that he has so well documented. There are many subterranean features that are also, in my opinion, evidence of rapid erosion. For example, some of the passages in Mammoth Cave, Kentucky, are truly enormous (see figure 1); yet they exhibit the smoothly rounded walls and ceilings that one would expect from huge volumes of water rushing through them. I also have documented many smoothly contoured features in my article on a much smaller cave, Hamilton Cave, West Virginia.<sup>5</sup>

An objection to erosion being a significant factor in speleogenesis is the fact that limestone, which is readily dissolved by acid, is where we almost always find caves. If erosion is so important, then why aren't other kinds of strata also riddled with caves? I believe that erosion is important, but that its combination with dissolution is also required. Also, are there other factors contributing to cave formation in limestone, as opposed to sandstone, shale, etc., besides its solubility in acid? Is limestone more susceptible to fracturing during uplift than other kinds of strata? Perhaps limestone consolidates faster and would therefore be more likely to fracture than to just bend when subjected to uplift pressure. I believe these possibilities need to be explored by experimentation.

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3. Oard, ref. 1, p. 76.
4. Palmer, A.N., The origin of maze caves, *The NSS Bulletin* 37(3):57–76, 1975; p. 71.
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## » Michael J. Oard replies:

I thank Art Manning for his comments. At the time Palmer<sup>1</sup> made this statement (1991), uniformitarian scientists believed only about 10% of caves were excavated by sulfuric acid. New information from Klimchouk and others indicates that probably more than 50% were excavated by sulfuric acid.<sup>2</sup> The trend is in the right direction for recognizing all caves were excavated by sulfuric acid. For those caves that do not provide evidence, I suggested that the evidence could have been washed out.

Manning suggests that the excavation of caves was by erosion of water when “such enlarging fractures reached the surface of the Flood-covered strata”. I presume this is the interface of the strata and the floodwater. This presumably would have caused a fast flow of water into the strata, causing erosion, especially by cavitation. It looks to me that there would be a problem causing suction of floodwater down into the strata. The direction of flow would be determined by the fluid pressure gradient. Before uplift and cracking of the limestone, the fluid within the limestone would have been under the pressure of the floodwater and the overburden. As uplift occurred and water depth lessened, the pressure gradient should have been out from the sediment. We have a post-Flood analog of this situation in the rhythmites in the Walla Walla River Valley, Washington, USA, where a deep lake lasted for 5 days. When it drained, clastic dikes

were formed from the bottom to the top due to the decreasing pressure of the water.

Manning suggests that we need to ditch the sulfuric acid dissolution model. However, there is abundant evidence for such dissolution in many caves. And in a Flood model with formation of expansion cracks, dissolution would be rapid. In reference to the Big Room in Carlsbad Cavern, there would also be erosion by water flow during dissolution, as in all caves, and it would not be slow when the whole area is rapidly uplifting out of the floodwater. The deposition of gypsum would stop the sulfuric acid erosion. Although there may be locations where gypsum is plastered against the walls of the cavern, I saw about 3 or 4 metres on the bottom of the cavern in one location. This would not have stopped dissolution of the areas of the roof, walls, and the bottom not covered by gypsum. Of course, the reaction with the limestone would have diminished the amount of sulfuric acid, and this could have eventually limited the growth of caves. I cannot see any meteoritic water affecting the origin of caves.

The reason we find caves mainly in limestone is because sulfuric acid will react with it, while in sandstone and shale with much quartz, sulfuric acid does not dissolve the quartz that makes up a high number of framework grains.

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## The 'poor tooth design' claim refuted

I'm writing in reference to the recent article "The 'poor tooth design' claim refuted", offered by Dr Jerry Bergman in *Journal of Creation* 34(1), 2020. The article was well written and inclusive of many ideas that lead to tooth fracture. Bergman did an excellent job describing the 'guts' of teeth and enamel makeup. I would simply and humbly like to add that the predominant reasons for tooth failure, whether natural enamel or those restored with fillings or fabricated crown restorations, were only lightly touched upon in the article while a more compelling and pervasive explanation exists.

It is true that intact teeth are subject to ruin by bacteria, both in decay and periodontal disease. It is also true that restored teeth, either by fillings or crowns, are practically found to be even weaker. When you combine weaker teeth with the following information, well, let's just say that's what keeps dentists in business. As I tell my patients, teeth with crowns have a checkered past! And there is no argument at all with the superior design of intact dental enamel and the design of teeth, the jaw structures, *particularly* the temporomandibular joint (TMJ) and the occluso-muscle relationship between them. I would even say ingenious!

By far, in day-to-day dentistry, the most prominent reason for intact enamel failure is occluso-muscular wear, often termed bruxism (figure 1), where the teeth are at the mercy of the muscles which gird and guide the mandible, all the while shepherded by the anatomy of (hopefully) healthy TMJs. The study of this relationship has come to be titled 'OD' (Occlusal Disease).



**Figure 1.** Worn teeth due to occluso-muscular wear or teeth grinding (bruxism). The front teeth have been ground down over time.

Treating the effects of OD now comprises at least 60% of my practice. In short, muscle always wins and will carve a path of destruction.

There is a plethora of muscles that are 'in charge' of guiding the mandible in all of its excursions. As humans, we don't 'chomp' like alligators; our mandibles also move side-to-side in an infinite number of directions. Throw in the teeth and you have the makings for masterfully masticating a satisfying meal. But the teeth, their numbers, their anatomy (shapes) and their relative position to each other (side-to-side and inter-arch) all play a part in determining best function and in protecting each other from excessive wear.

If those teeth, however, are misaligned, missing, over- or under-restored, and placed in 'conflict' with the workings of healthy muscles, even God's brilliant design of enamel will not prevent them from giving way. The best designed and constructed buildings of the strongest material can all meet their match, when challenged by the forces of nature.

There is so much more to this discussion: size and growth of jaws, modern dietary factors, etc., which Bergman touched on, are all important

factors. The most current and compelling information and research now includes the size/volume of the airway in its relation to jaw growth and proper nasal breathing. This is known to directly affect tooth position, thereby affecting function, hygiene, need for restorations and the impact of those very strong muscles.

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# New *Homo erectus* crania associated with stone tools raise issues

Peter Line

A recent paper describing two new *Homo erectus* crania from Ethiopia, found directly associated with both Mode 1 and Mode 2 stone tools, raises issues regarding *Homo erectus*. This article discusses some of these issues, including the stone tools, the small cranial capacity, the robust form of the cranium, and the location and setting in which these fossils were found.

In early March 2020 Semaw *et al.* published a paper titled “Co-occurrence of Acheulian and Oldowan artifacts with *Homo erectus* cranial fossils from Gona, Afar, Ethiopia”.<sup>1</sup> The paper raises issues regarding *Homo erectus* that are important to address from a creation point of view. Included in the article is the description of two adult *Homo erectus* crania from the Gona Project study area, Afar, Ethiopia, neither of which appear to have been published before, even though they were discovered about two decades ago. The larger BSN12/P1 (partial) cranium was discovered in 1999 at the Busidima North site #12, while the smaller DAN5/P1 (relatively well-preserved) cranium (figure 1) was discovered in 2000 at the Dana Aoula North locality #1.<sup>2</sup> Although evolutionary (geological) ages of strata and/or fossils are given in this article as information to the reader, I do not accept the validity of these age dates.

## Stone tools

An item of interest highlighted by the publication was the direct association of Oldowan and Acheulian stone tools with both crania, these being found about 5.7 km apart, and supposedly separated temporally by at least 240,000 years.<sup>3</sup> According to Semaw *et al.*:

“Here, we report combined Oldowan (Mode 1) and Acheulian (Mode 2) stone tool assemblages and hominin cranial fossils found in direct association that derive from stratigraphic levels dating to 1.26 Ma ago at Busidima North (BSN12) and approximately 1.6 to 1.5 Ma ago at Dana Aoule North (DAN5) ... which illuminate *H. erectus* variability and behavioral flexibility.”<sup>4</sup>

The authors remarked that it was their observation at Gona and elsewhere that many archaeological sites dating from 0.5 to 1.6 Ma (million years ago) only contained Mode 1 stone tools, and that the Gona evidence suggested “that most of these Mode 1 sites were created by *H. erectus* (sensu lato), not a different hominin species, particularly in areas

that do not preserve evidence of other hominins in the Middle Pleistocene, such as the Afar”.<sup>5</sup> They regarded the evidence at Gona as suggesting that *Homo erectus* “had population-level behavioral diversity and flexibility, with a lengthy and concurrent use of both Mode 1 and Mode 2 technologies”.<sup>5</sup>

Hence, as indicated above, the finding of a direct association of both simple Oldowan tools and the relatively more complex Acheulian stone tools with *Homo erectus* crania is strong evidence that humans classified as *Homo erectus* made and used both types of stone tools (i.e. Modes 1 and 2).

From a creation point of view, where evolutionary age dates are not accepted, this indicates that *Homo erectus* (not *Homo habilis*) individuals were also the likely makers of the Oldowan stone tools at Olduvai Gorge, Tanzania, and other places. *Homo habilis* sensu lato (in a broad sense, e.g. incorporating *Homo rudolfensis*) have usually been assumed to be the manufacturers of the first known (Oldowan) tools, “even though fossil remains have not usually been found in direct association with the tools”.<sup>6</sup> As detailed elsewhere, *Homo habilis* is likely a phantom species, i.e. a ‘composite taxon’ made up of mainly australopithecines, but also likely a few *Homo erectus* remains, that have been bundled together and marketed as a species of ‘apeman’.<sup>7</sup>

There is a caveat to the interpretation of artefacts as Oldowan tools, however. Capuchin monkeys have been observed deliberately breaking stones, unintentionally producing fragments stated as “recurrent, conchoidally fractured, sharp-edged flakes and cores that have the characteristics and morphology of intentionally produced hominin tools”.<sup>8</sup> Apparently, as reported by Ewen Callaway, “About half of the flakes made by the capuchins bore the hallmarks of Oldowan tools called choppers, says Proffitt”,<sup>9</sup> the latter being the first author of the study. Hence, if Oldowan-like tools could be produced this easily, it makes one wonder whether some of the so-called Oldowan tools were simply accidental by-products of stone breakage, and not necessarily by human hands. Another suggestion, by co-author of the Gona *Homo erectus* paper, Michael Rogers, as articulated by Ruth

Schuster, is that “Possibly the worked stones perceived as Mode I tools were by-products of the manufacturing process of making Mode II implements.”<sup>10</sup>

Oldowan (Mode 1) tools are basic, essentially “made by smashing two rocks together to form a sharp flake”, whereas Acheulian tools (Mode 2) are more complex, being “made by repeatedly chipping away at a rock to shape it into a hand axe”.<sup>11</sup> The Acheulian handaxes (figure 2) are typically teardrop-shaped. They are thought by evolutionists to have first been made by *Homo erectus* sensu lato, and, according to Stringer and Andrews, “The people who made the handaxes clearly had a specific shape in mind, and often went far beyond a purely utilitarian form in the care with which they produced them.”<sup>12</sup> Hence, from a creation point of view, such purposeful manufacture of a tool has the hallmarks of human activity, indicating that *Homo erectus* individuals were fully human.

### Location and setting

Fossilized remains of *Homo erectus* sensu lato have been discovered in the landmasses of Africa and Eurasia. They appear to be concentrated in several regions, including Java (the central island of Indonesia), China, East Africa (Kenya, Tanzania, Eritrea, Ethiopia), and Georgia (the Dmanisi remains). Remains have also been found in North Africa (Salé 1 cranium from Morocco) and India (Narmada cranium).<sup>13</sup> *Homo erectus* remains have also been found in Denizli, Turkey; namely the partial Kocabaş skullcap.<sup>14</sup> Some researchers view the Ceprano 1 calvarium as belonging to

*Homo erectus*, which would also place the species in Italy.<sup>15</sup> Ronald Clarke has also suggested that the partial cranium SK 847, from Swartkrans, South Africa, should be classified as an early *Homo erectus*.<sup>16</sup> The two new *Homo erectus* cranial fossils were from Gona, Afar, Ethiopia, and, according to Semaw *et al.*:

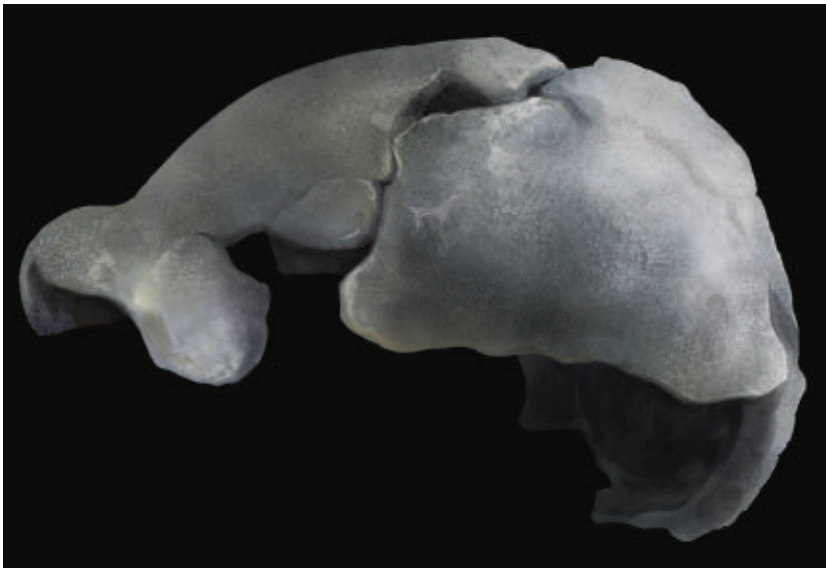
“Hominin remains and artifacts at DAN5 and BSN12 were discovered in the Busidima Formation, which lies above the well-known Hadar Formation and spans ~2.7 to <0.16 Ma ... The Busidima Formation consists of stacked fining upwards packages of fluvial deposits laid down by a paleo-Awash River.”<sup>17</sup>

The BSN12/P1 cranium (and associated Mode 1 and Mode 2 artifacts) was found in direct association with the Boolihinan Tuff (BHT) stratigraphic level, where 28 metres “of reversely magnetized sediments overlie the BHT, capped by an additional 18+ m of normally magnetized sediments”.<sup>4</sup> The DAN5/P1 cranium and associated artifacts (Mode 1 and Mode 2 tools), found at the DAN5 locality, were said to have

“... come from a siltstone unit in reversed magnetized sediments 6.5 m above the top of the Olduvai Subchron and 10.5 m below the base of the Jaramillo Subchron ... , with a well-developed, 8- to 9-m-thick, cumulic paleosol separating the artifacts and cranium from the normally magnetized stratigraphic interval above ... ”<sup>18</sup>

The above setting shows similarities to other *Homo erectus* fossil finds. In a survey of *Homo erectus* crania (where cranial capacity had been estimated), the setting in which many of these crania were found was sediments deposited by water.<sup>13</sup> With these *Homo erectus* fossils we are generally not referring to remains that have been deliberately buried, as is the case with some modern human or Neandertal remains; rather crania, and sometimes scraps of other postcranial material, exposed by erosion of the deposits, or otherwise discovered (e.g. by excavation).

For many of these *Homo erectus* crania (or postcranial remains) to be buried in sediments and subsequently fossilized, and then for the stratigraphic layers of these sediments to later be exposed/eroded, by whatever mechanism, would take time. This is apart from the time it would take for the individuals to migrate to these regions, some of which (e.g. Indonesia) would involve lengthy journeys. Hence, if these fossils were of individuals post-Flood, then it seems likely



**Figure 1.** The adult *Homo erectus* DAN5/P1 cranium from Gona, Afar, Ethiopia. Its cranial capacity (598 cc) is the smallest of any adult *Homo erectus* specimen from Africa. Illustration based on photo by Michael J. Rogers, Southern Connecticut State University.<sup>11</sup>



they represent migrations of people that began very early post-Flood.

In terms of affinity, the more complete and smaller DAN5/P1 cranium is said to show similarity to the Dmanisi crania (1.76–1.85 Ma) from Georgia, the juvenile KNM-ER 42700 cranium (1.5–1.6 Ma) from Kenya, and the small Olororgesailie (KNM-OL 45500) cranium (0.95 Ma) from Kenya, all *Homo erectus*.<sup>19</sup> In regard to the larger and very incomplete BSN12/P1 cranium, it is stated as

“... similar to the more robust African specimens such as Olduvai Hominid 9, the ca. 1-Ma specimens from Middle Awash, Ethiopia [BOU-VP-2/66 ...] and Buia, Eritrea [UA-31 ...], and those from Indonesia and eastern Asia by having a longer and lower vault with a thickened supraorbital torus.”<sup>19</sup>

Although the features in *Homo erectus* crania vary, there are also similarities, even between specimens as far apart as Africa and Indonesia, as indicated above. A possible, logical explanation for this would be that all the *Homo erectus* individuals from these different regions of the world ultimately trace their origins back to an original and diverse ‘*Homo erectus*’ population, likely from Babel.

### Cranial capacity in *Homo erectus*

According to Stephen Molnar, the mean cranial capacity for modern humans is 1345 cc (cubic centimetres).<sup>20</sup> In comparison, the mean cranial capacity of 48 *Homo erectus* crania was calculated to be about 934 cc (range of 48 crania was 546 cc to 1260 cc), which is about 70% of the mean cranial capacity in modern humans.<sup>13</sup> A smaller body size on average in *Homo erectus* may account for some of the difference in cranial capacity, but not all. The smaller Gona DAN5/P1 cranium was estimated to have a cranial capacity of ~598 cc, whereas the larger and partial Gona BSN12/P1 cranium was estimated to have a cranial capacity between 800 and 900 cc.<sup>19</sup> While the cranial capacity of the BSN12/P1 cranium is close to the mean of *Homo erectus*, that of the DAN5/P1 cranium is very much at the lower end of the range, having the smallest adult *Homo erectus* cranial capacity known in Africa. Adding these two crania to the 48 crania above (using the mean value of 850 cc for BSN12/P1 cranium), the mean cranial capacity of 50 *Homo erectus* crania is about 926 cc. Hence, it may be validly asked why the cranial capacities of all *Homo erectus* crania are below the modern human mean, some being considerably below. However, this may not necessarily be true.

For example, consider the Xuchang crania, evolutionarily dated from ~105 to 125 ka (thousand years ago), from Lingjing, Xuchang, China, which are referred to as “Late Pleistocene archaic human crania” by the authors.<sup>21</sup> The cranial capacity of one cranium (Xuchang 1) is estimated

at 1,800 cc, considerably above the modern human mean of 1,345 cc, and exhibits *Homo erectus* features, such as prominent brow ridge, a nuchal torus (although small), low vault height, and the widest point of the cranium being low.<sup>21</sup> According to Roberto Sáez, the Xuchang skulls were initially considered *Homo erectus*.<sup>22</sup> On the Xuchang crania Ann Gibbons writes:

“Nor are the new fossils late-occurring representatives of other archaic humans such as *H. erectus* or *H. heidelbergensis*, two species that were ancestral to Neandertals and modern humans. The skulls are too lightly built and their brains are too big, according to the paper.”<sup>23</sup>

In her brief article, Gibbons discusses the possibility that the crania belong to the mystery species, the Denisovans. But is ruling out *Homo erectus* a bit hasty? Another relevant question is whether the Denisovans were indeed *Homo erectus*, but that is not the focus here. Thickness of the cranial vault is arguably best measured by the thickness at the parietal eminence (a prominence near the centre of the external surface of the parietal bone), and this measurement in Xuchang 1 (7.9 mm<sup>24</sup>) is still within the lower range (7.5 mm) of *Homo erectus* measurements by Kennedy.<sup>25</sup> Although this measurement was not given for the newly described *Homo erectus* crania, the vault thicknesses at another point on the cranium, called the bregma (junction point of the coronal and sagittal sutures), were listed as 7 mm and 8 mm for the DAN5/P1 and BSN12/P1 crania, respectively,<sup>26</sup> compared to



**Figure 2.** A cast of an Acheulian handaxe (Mode 2 stone tool), believed by evolutionists to have been invented by *Homo erectus* (sensu lato). Photo by Peter Line.

8 mm at the bregma for the Xuchang 1 cranium.<sup>27</sup> Being ‘lightly built’ would involve thin cranial vault bones, but the thickness of the vault bones appear to be still within the *Homo erectus* range for the Xuchang 1 cranium, as indicated above, along with the other *erectus*-like features. This indicates that it may essentially only be large brain size and changes to the form of the braincase (likely related to brain expansion) that rule out the Xuchang 1 cranium from being assigned to *Homo erectus*.

If crania are ruled out from belonging to *Homo erectus* essentially because of a large cranial capacity, then of course one will end up with a ‘species’ of only small-brained individuals.

As such, and as a perfect example of faulty logic and circular reasoning, after arbitrarily ruling out crania with large cranial capacities as belonging to *Homo erectus*, some evolutionists then use this as proof that there are no *Homo erectus* crania with large cranial capacities.

Also, the boundary between *Homo erectus* and *Homo heidelbergensis* crania (figure 3) appears blurry, with cranial capacity an important factor influencing taxonomic status.<sup>28</sup> Therefore, *Homo erectus* and *Homo heidelbergensis* should not be regarded as separate ‘species’. The cranial capacity range of 30 fossil specimens assigned to *Homo heidelbergensis* sensu lato is between 1,057.5 and 1,450 cc (the mean is about 1,244 cc).<sup>29</sup>

Considering the above factors, it does not appear correct to conclude that the cranial capacities of all *Homo erectus* crania are below the modern human mean, nor that a smaller cranial capacity correlates with greater robusticity. In this regard, it should be pointed out that the smaller Gona DAN5/P1 cranium was stated by Semaw *et al.* as being “more gracile”, whereas the larger Gona BSN12/P1 cranium was described as “more robust”.<sup>19</sup> To explain the difference in size and morphology between the Gona specimens, the authors suggested that the older DAN5/P1 individual may have retained “more primitive anatomy (e.g. smaller size, gracile vault, and thin supraorbital tori) than the younger BSN12/P1 fossil”, or that the variation between the two specimens was “primarily a consequence of sexual dimorphism within a single species”, or that the “fossils might reflect a degree of taxonomic diversity previously unrecognized in the Afar for the genus *Homo*”.<sup>19</sup>

### Small cranial capacity in *Homo erectus*

An important question is why so many of the *Homo erectus* crania have a small cranial capacity. Some specimens with



**Figure 3.** Casts of the adult Sangiran 17 *Homo erectus* cranium (left) from Java, Indonesia (cranial capacity ~1,004 cc), and adult Kabwe *Homo heidelbergensis* cranium from Kabwe, Zambia (cranial capacity ~1,325 cc). Photo by Peter Line.

small cranial capacities, such as those from Dmanisi, Georgia, in particular Skull 5 (figure 4), consisting of the cranium D4500 and the lower jaw D2600,<sup>30</sup> can possibly be explained by pathology, such as cretinism, in some members of a local ‘*Homo erectus*’ population.<sup>13</sup> With a cranial capacity of 546 cc, the adult D4500 cranium has the smallest cranial capacity of the Dmanisi sample (and any adult *Homo erectus* specimen known), although the cranial capacities of the other four Dmanisi crania (D2280: 730 cc; D2282: 650–660 cc; D2700: 600 cc; D3444: 625 cc)<sup>31</sup> are also well below the average for *Homo erectus*. Cretinism (congenital hypothyroidism) “can reduce brain size by approximately 50%”,<sup>32</sup> and so would be one possible explanation for the low cranial capacity observed in some of the Dmanisi crania. The very small brain size, as inferred by the small cranial capacities (brain size and cranial capacity are positively correlated), and the variability in craniomandibular morphology seen in specimens from the Dmanisi sample, including the odd-looking Skull 5, indicate something abnormal about this population. Similarly, the *Homo naledi* fossil sample from South Africa may, rather than being a new ‘species’, instead consist of ‘*erectus*-like’ humans, some of whom suffered from cretinism (explaining some of the strange morphology).<sup>33</sup>

However, while some small-brained *Homo erectus* specimens can possibly be explained as a result of pathology, there are too many specimens with small cranial capacity for pathology to be an explanation for all of them. And even if some may have been pathological, it is more likely that they were, for example, pathological *Homo erectus*-type humans, not pathological anatomically modern humans. The most logical conclusion appears to be that most *Homo erectus* specimens were not pathological and that there was a huge natural variation in cranial capacity of these humans, particularly if you include *Homo heidelbergensis* and other specimens (even the Neandertals) as part of this group (I

prefer to call them ‘robust humans’). For reasons unknown many members of this group had small brain size, and hence small cranial capacity.

### Small cranial capacity in anatomically modern humans

Is it possible that the newly described Gona DAN5/P1 cranium, with an estimated cranial capacity of ~598 cc, was of a *Homo erectus* individual with ‘normal’ human intelligence? Given that the DAN5/P1 cranium was directly associated with both simple Oldowan and more complex Acheulian tools, this is a very important question.

According to Kliemann *et al.*, “Patients who had hemispherectomy in childhood may retain surprisingly high levels of cognitive and sensorimotor abilities.”<sup>34</sup> Hemispherectomy is the surgical removal of one cerebral hemisphere (half of the brain). The authors also noted that “Language function has been studied in some detail, also showing near-complete recovery in many patients who had their language-dominant hemisphere resected [cut out].”<sup>35</sup> Hence, this indicates that a large brain mass is not essential in order to have relatively ‘normal’ intelligence.

As the brain size or cranial capacity (and intelligence) of only a miniscule fraction of the billions of anatomically modern humans that exist (or have existed) have been measured or estimated, it is difficult to know what the lower limit of brain size for ‘normal’ intelligence is. One of the smallest brain sizes documented of a modern human with normal intelligence was from Daniel Lyon, a man of small stature (height of 1.55 m; weight 65.8 kg), with a brain that weighed 680 grams, yielding a brain volume of 624 cc, as calculated by John Skoyles.<sup>36</sup> Using formulae linking brain volume or brain mass to cranial capacity, the cranial capacity of Lyon’s cranium can be estimated to be about 660 cc or 694 cc, depending on the method used.<sup>13</sup> Perhaps the mean (677 cc) of the two values is the most reasonable estimate. This indicates, at least in theory, that most of the small-brained *Homo erectus* specimens, possibly including the individual associated with the DAN5/P1 cranium, could have been people with ‘normal’ intelligence.

### The form of the *Homo erectus* cranium

A subject of importance to the creation model is explaining why the skeletons, particularly the skulls, of humans such as *Homo erectus* (as well as those classified as Neandertals and *Homo heidelbergensis*), were so rugged or robust compared to anatomically modern humans. Some creationists see environmental factors and genetic effects, such as the founder effect, genetic drift, and inbreeding, as most likely sufficient to explain the differences in skeletal features between modern

humans and so-called cavemen.<sup>37</sup> It has been proposed that there was a period of rapid human diversification beginning during the construction of Babel, resulting in extreme morphological variability in post-Babel humans repopulating the earth.<sup>38,39</sup> Other creationists believe the stark difference in morphology between robust and anatomically modern humans warrants an explanation per se, that is, not just an acknowledgment that there was considerable variation in features, but why.

As such, it has been suggested that *Homo erectus*, Neandertals and the like all arose via ‘devolution’ from anatomically modern post-Babel populations—from the genetic consequences of inbreeding, drift, and mutational effects, after splitting off from anatomically modern humans.<sup>40</sup> However, this would have to have happened independently, in a relatively short time, in many different parts of the world, which seems a little too coincidental to be realistic.

Along with a number of other creationists who have contemplated this issue, I consider the robust human forms, such as those with the features observed in the typical *Homo erectus* and Neandertal remains, to in general be non-pathological. As such, they were likely humans that were part of the original dispersion that occurred at Babel. Hence, an explanation that is worth considering is that the robust morphology observed in these humans is linked to longevity. According to creationist Carl Wieland:

“The extinction of human lines with more robust morphology (Neanderthal, *erectus*) may correlate with extinction of longevity. The robusticity may be the result of genetic longevity/delayed maturation or the same populations may have had [possibly linked] genes for longevity and robusticity.”<sup>41</sup>

Hence, one explanation why humans such as *Homo erectus*, *Homo heidelbergensis*, and Neandertals, had different morphology compared to modern humans, particularly in the skull, is that it could reflect changes in development of these early post-Flood individuals, compared to modern humans, possibly linked to longevity.<sup>42</sup> A factor that cannot be ignored in a creationist model of human origins is the biblical long lifespans of individuals in the pre-Flood world, and to some extent the early post-Flood earth, as derived from Old Testament records. In the pre-Flood world lifespans of around 900 years appear to have been common, and even individuals born early post-Flood (within a few hundred years of the Flood having occurred) are recorded as having lived for hundreds of years.<sup>43,44</sup>

If initially (after the Fall) humans were designed to live for hundreds of years, then this would most likely have a bearing on development processes and timings. Simply put, longevity would probably be associated with changes in development, not just the aging process. Having thickened cranial vault bones, a heavily built face, thick-boned jaws, and thick



postcranial bones may have been necessary, or at least an advantage, for the body to cope with these long lifespans.

If longevity was linked to development processes associated with the above-mentioned robusticity, then robust features would be expected to disappear with shorter lifespans, although, as Wieland notes, “some of the genes coding for some of their distinctive bony anatomy were apparently passed on to some of today’s populations”.<sup>45</sup> Hence, robust features do not correlate with the potential for longevity in recent times. A genetic mechanism for robusticity would possibly involve the control of hormones related to bone growth and maintenance. According to Susan Crockford, an evolutionary expert in this area, the

“... distinctive skeletal morphology possessed by Neandertals is almost certainly the result of a pattern of thyroxine secretion (and, therefore, of prenatal and postnatal growth rates) that differed markedly and consistently from that of modern humans. These

Neandertal traits may resemble superficially the pathological changes associated with congenital iodine deficiency because they reflect different amounts of thyroxine available for skeletal growth at particular stages of development as compared with healthy modern humans.”<sup>46</sup>

Thyroxine (T4) is an important thyroid hormone, and a certain thyroid hormone secretion pattern could have existed in people with robust skeletal morphology, such as *Homo erectus* and the Neandertals, linked to the genetic mechanism for long lifespans. Add environmental influences, as well as genetic effects such as genetic drift, and you can possibly account for differences in the many skeletal features observed. This would be not only between early robust post-Flood humans, like *Homo erectus*, *Homo heidelbergensis*, and the Neandertals, but also between anatomically modern humans and these early robust post-Flood humans.

Explaining the skeletal form, particularly the crania, of robust humans, such as *Homo erectus*, is very much a work in progress. It is hoped that further work in this area will yield more answers or clues as to why these robust humans possessed crania that appear rugged and/or robust compared to the relatively gracile crania typical of anatomically modern humans.

## Conclusions

The recent paper describing two new *Homo erectus* crania directly associated with both Oldowan and Acheulian stone tools raises issues regarding *Homo erectus* that are of great interest to the creation model of human origins. The latest evidence indicates that humans classified as *Homo erectus* made both Acheulian and Oldowan stone tools, although the simplicity of making the latter indicates that some Oldowan tools could possibly have been by-products of manufacturing the Acheulian tools. Also, the phantom species *Homo habilis* (most of whose members should be reassigned to the australopithecines) was likely not the maker of Oldowan tools. Although a high proportion of *Homo erectus* crania have small cranial capacities, the robust nature of *Homo erectus* crania is not necessarily linked to small brain



**Figure 4.** Cast of the adult *Homo erectus* skull from Dmanisi, Georgia, known as Skull 5, consisting of the cranium (D4500) and the lower jaw (D2600). Photo by Peter Line.

size, as *Homo erectus* appears to be a species by and large arbitrarily defined as having a small cranial capacity. If other robust human crania are included in the *Homo erectus* group, like those belonging to *Homo heidelbergensis*, the Xuchang crania, and even the Neandertals, then the correlation between cranial robusticity and cranial capacity disappears. Why there is a high proportion of robust *Homo erectus* crania with small cranial capacities is unclear, but information from recent anatomically modern humans indicates that most of the small-brained *Homo erectus* individuals could, at least in theory, have possessed ‘normal’ intelligence. Why the robust cranial form seen in *Homo erectus* is different from that in anatomically modern humans is a matter of debate, with more work needed to be done in this area.

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Peter Line's undergraduate major was in biophysics. After that he completed a Masters Degree and a Ph.D., both in the area of neuroscience. He has had a keen interest in the creation/evolution issue ever since becoming a Christian, as evolution was a stumbling block to him believing God's Word was true.

# Useless ear muscles are useful

Jerry Bergman

This paper reviews the claim that humans evolved from an animal that could move its outer ear to maximize its hearing by directing the pinna towards the sound source. This theory is used to support the claim that the small muscles located around the temporal bone of the human head are vestigial. It is documented that the framework of the human ear was not designed to move, and the muscles connected to it serve several other functions, including as part of the muscle system in the temple area to support blood circulation in the area of the cranium where they are located, and as padding to protect the underlying structures. Their major roles are to cover and protect the area around the ear and to help stabilize the pinna in its proper location.

The evolutionary explanation for the claim that some humans can wiggle their ears is explained by Sanford University graduate student Dara Strauss-Albee:

“Ear wiggling happens through muscles above and behind your ears called auriculars. In some animals, these muscles are useful because ear movement is helpful. A cat, for example, can move its ears to help it listen for tasty birds. But why would humans have these muscles? Way back when, humans and cats had the same ancestors. Ear wiggling was useful to this shared ancestor. Now, humans and cats have become very different. Ear wiggling is still useful to our feline friends. But for us, it’s just a cool party trick. The name for this is a vestigial trait.”<sup>1</sup>

Another typical example of this common claim is: “... there’s an entire group of muscles attached to our ears that, for most monkeys, are used to move the ears like satellite dishes trying to pick up a signal. For us, however, they just sit there—not moving anything—suggesting that they’ve lost their biological function.”<sup>2</sup>

A scholarly reference made the same claim:

“The auricular muscles are vestigial in humans and few individuals can move their ears voluntarily. As a result, the auricular muscles are generally considered to be of little functional significance, although auricular reflexes activate ear muscles during eye movements.”<sup>3</sup>

Professor Hackley explains why evolutionists use the vestigial organ claim as evidence for evolution. He writes, “If evolution were guided by a supernatural being with perfect intelligence, then one might expect that there would be no vestigial, useless parts of our body”, but, he argues, “many examples exist including the ear muscles”.<sup>4</sup>

The assertion that certain ear muscles are vestigial has a very long history. One of many examples of this particular useless-organ claim is found in a book first published in 1920. The author wrote within a caption below an ear illustration:

“... the useless muscles of our ears [are] relics of those that enabled our wild ancestors to move these organs so as to catch every sound, just as horses and foxes do today. Human beings and the higher apes have almost entirely lost this power to move their ears, though here and there an individual turns up who can do so to a slight extent.”<sup>5</sup>

The useless ear muscles idea dates back to Darwin’s 1871 book where he wrote the “whole external shell of the ear may be considered a rudiment [the word he used instead of vestigial] together with the [ear’s] various folds and prominences (helix and anti-helix, tragus and anti-tragus).”<sup>6</sup> Dara Strauss-Albee notes that the auricular muscles, though vestigial, *do* serve an important function:

“If ear wiggling isn’t useful to humans anymore, will it ever disappear? That’s not very likely. The auriculars came about a very long time ago. For ear wiggling to disappear, these muscles would have to disappear, too. And that wouldn’t be easy. Basically, they would have to mutate away. ... However, for the auriculars, it’s unlikely they will mutate enough to disappear. They ... still form an *important base* for the ear. Evolution can only build on what came before, so it might not be possible to get rid of them and still have ears! [emphasis added]”<sup>1</sup>

Darwin hypothesized that the auricular muscles are vestigial, stating that ear muscles were lost because humans could “effectively capture sounds by positioning their head to compensate for the loss of, or eliminating the need for the auricular muscles.”<sup>7</sup>

He also implied that the ability to move the ears would be very useful for humans, causing one to wonder why it would be lost as evolutionists assert:

“The power of erecting and directing the shell of the ears to the various points of the compass, is no doubt of the highest service to many animals, as they



thus perceive the direction of danger; but I have never heard, on sufficient evidence, of a man who possessed this power, the one which might be of use to him.”<sup>8</sup>

In the *Ascent of Man* (1894) it was opined that the power to wiggle one’s ear pinna is not lost, and “every school boy can point to someone in his class who retains the capacity”.<sup>9</sup> The fact is, the author added, movement “of the ear, in order to catch sound better, is a power possessed by almost all mammals, and the attached muscles are large and greatly developed in all but domesticated forms” of animals.<sup>10</sup>

This claim is still expressed today. Stephaine Pappas claims that “these muscles are vestigial, meaning they’re remnants of evolution that once had a purpose but no longer do”.<sup>11</sup> Of the seven most important examples of useless organs, one list of vestigial organs listed as number three the auricular, or extrinsic, muscles of the human ear that

“... control the pinna, or the visible part of the ear.

In many mammals, ear movements produced by the auricular muscles play a role in sound localization and the expression of emotion, but in humans, the muscles are considered nonfunctional. Through repeated effort, however, humans can recover some ability to wiggle their ears.”<sup>7</sup>

### The vestigial-organ claim

The vestigial-organ claim is still widely touted by evolutionists as major evidence for evolution despite the clear evidence that all such vestigial organ claims are outdated or simply wrong.<sup>12</sup> The 2020 *Encyclopaedia Britannica* claimed:

“Vestiges are remnants of evolutionary history—‘footprints’ or ‘tracks’, as translated from the Latin *vestigial*. All species possess vestigial features, which range in type from anatomical to physiological to behavioral. More than 100 vestigial anomalies occur in humans.”<sup>7</sup>

In fact, no valid examples of useless vestigial organs remain in humans; all claimed examples have been documented to have one or more functions.<sup>13</sup> Some assert that vestiges do not have to be useless to be labelled vestigial, but only less useful (and/or useful for a different purpose) than in our evolutionary past. University of Chicago evolutionist

Jerry Coyne defines vestigial as follows: “A trait can be vestigial and functional at the same time. It is vestigial not because it’s functionless, but because it no longer performs the function for which it evolved.”<sup>14</sup>

Given this definition, one could claim many very important systems, such as smell in humans, are vestigial. Animals with olfactory systems far superior to humans include elephants, cows, dogs, horses, rabbits, rats, mice, and guinea pigs.<sup>15</sup> According to Coyne’s definition, the human olfactory system could thus be considered to be vestigial, but is never listed as such. Probably evolutionists realize they are losing this argument for evolution:

“In the battle over evolution, creationists and believers in an intelligent designer often claim that so-called vestigial organs have a purpose. And in many cases, they do. The appendix, for example, was long thought to be an intestinal dead end before scientists found that

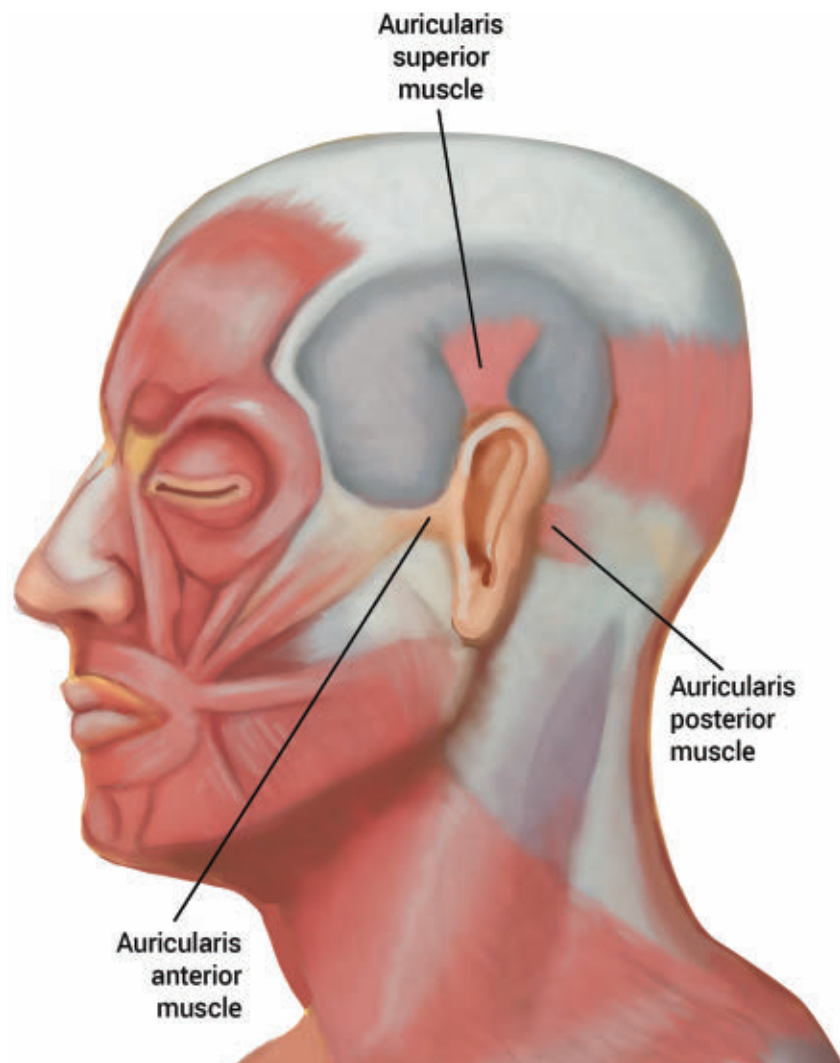


Figure 1. Auricular muscles connected to the human ear

it can protect helpful bacteria during illness, allowing the useful microbes to repopulate the gut.”<sup>11</sup>

Only one website of the 43 that I found from an internet search of vestigial organs acknowledged that “many biologists now say that there are no vestigial organs in [the] human body”.<sup>16</sup>

### Ear muscles as useless

One of the oldest useless-organ claims involves the comparatively small muscles surrounding the pinna or outer ear. In man, “these muscles possess very little action”.<sup>17</sup> The external ear area houses three extrinsic auricular muscles, namely the posterior, superior, and anterior auricular muscles, and six intrinsic muscles, the helicis major and minor, tragus, anti-tragus, transverse and oblique muscles.<sup>18</sup> The *auricularis superior* is the fan-shaped muscle that arises from the temporal fascia (connective tissue along the side of the head) and descends into the root of the auricle (figure 1). The *anterior auricular muscle*, the smallest of the three auricular muscles, arises from the lateral edge of the galea aponeurotica, and its fibres are inserted into a projection on the front of the ear helix. The *auricularis posterior* is a facial muscle that helps maintain the base of the ear pinna position. This muscle originates at the part of the cranium located behind the ear called the mastoid process and inserts into the back portion of the base of the auricle.

The nine muscles mentioned above are part of a complex muscle system that is integrated with yet other muscles, including even masticatory muscles, and the temporalis muscle system (zygomaticomandibularis muscle, sphenomandibularis muscle; maxillomandibularis muscle; and buccinator muscle).<sup>19</sup> None of these muscles have any significant effect on moving the ear pinna to improve sound reception. They work as a unit as part of the cranium design for reasons discussed below.

Many quadrupeds have large functional muscles connected to their pinna. In comparison to many animals, humans have very few designated ear muscles. A cat uses 30 muscles to control its outer ear, and many dogs have 18 muscles designed for moving their ears. These muscles allow the cat’s ear to rotate 180°, enabling it to maximize hearing ability to its front and sides without moving its head. Rabbits can rotate their ears 270° and independently of each other to allow them to simultaneously pay attention to different sound sources.<sup>20</sup> Some bats can change the shape of their pinna to fine-tune echolocation sensing.<sup>21</sup>

In contrast, evolutionists claim that human ear muscles are retained “in a dwindled and useless condition” but in “baboons, macacus, [macaques] magots [Barbary apes] ... degeneration has not proceeded so far, and the ears are voluntarily movable”.<sup>22</sup> This assumes the muscles required to

move ears have degenerated as humans have evolved from our common ancestor into humans and non-human primates. From an evolutionary view, loss of these muscles would have handicapped humans’ ability to be fully aware of their surroundings due to their lower ability to be aware of the sound clues around them. Another evolutionary concern is that our claimed closest relative, the chimps, rarely move their ears and, from an evolutionary perspective, it is not known “what factors worked to diminish pinna size and mobility in primate evolution, but an increased ability to rotate the head may have played a role”.<sup>23</sup>

Most anatomists admit that with effort some humans have an ability to wiggle their ears, but even in these cases the muscles are unable to move the ear in an effective way such as many animals can. Also, the human ear pinna cannot pivot towards a sound source because the “extrinsic muscles are attached too near the base to achieve leverage” at a level necessary to move the pinna.<sup>4</sup> This is evidence that the pinna muscles were designed for other purposes.

### Ear muscles important for proper development

Professor Liugan *et al.*, after noting that the three extrinsic auricular muscles “have been considered vestigial in humans”, presents evidence that “during development in the womb they may exert forces on the cartilage and affect the shaping of the ear”.<sup>18</sup> Other studies have come to the same conclusion as documented by the fact that lack of proper development of these muscles causes problems in ear placement, in terms of both its location and stability.<sup>24,25</sup>

The stabilizing role of the muscles is important, as illustrated by the cases of persons clinically diagnosed with what is termed hypermobile ear due to failure of the superior and posterior auricularis muscles, and the thin concha cartilage, to develop during embryonic growth as a result of the absence of primordial tissue. This condition requires surgery to suture the concha cartilage to the mastoid bone and temporal fascia to provide sufficient support for the external ear’s stability.<sup>26</sup> This medical abnormality illustrates the importance of the auricularis muscles in positioning and stabilizing the ear. It also documents the fact that these muscles are not designed to move the ear, but rather stabilize its position.

### Other functions of auricular muscles

No claim is made in the literature that the ear muscles themselves have been lost or are being lost from generation to generation. Evidence also exists of an accidental uncommon trait involving minor involuntary ear wiggling or twitching. Classified as a focal dyskinesia,<sup>27</sup> this abnormality is described by otolaryngologists as an isolated dystonic movement of cranial musculature, causing a 1–3 mm

movement. They also note that a major function of the auricular muscles is to help hold the ear in its proper place, as shown by their origin and insertion points.<sup>28</sup> One study of agenesis of superior and posterior auricular muscles noted it resulted in hypermobility of the ear.<sup>26</sup>

All muscles exist for several reasons aside from producing movement. These include the production of heat, to add insulation, and serve as protection of the underlying tissue. The muscles of concern here cover a large portion of the temporal part of the cranium and virtually all of the cranium bones are covered with muscles, fasciae, and tendons (including aponeuroses) and connect to the cranium and scalp. In one electromyographic study, one major function of the anterior, superior, and posterior auricular muscles was their involvement in smiling and yawning (figure 2).<sup>29</sup> Tendons or sinews are tough fibrous connective tissue that connects muscle to bone and protects the underlying tissue. Furthermore, the ear structure area is the ideal attachment point for the temporal muscles surrounding the ear canal. Lastly, the pinna muscles are part of a large muscle network that engulfs the temple area of the skull. Lack of some of these muscles results in a gaunt sickly appearance that also affects the functions that these muscles provide.

### Reflexive action of auricular muscles

Although the auricular muscles in humans cannot move the pinna like those of many animals, they nonetheless have a reflex function. Given the fact that the human face is a critical means of communication, research has found these muscles are activated in response to several positive emotions. This fact is an important tool for psychologists and others seeking an objective way to measure emotion. The reflexive neural network includes innervation of auricular muscles for expressing emotional reactions and the startle reflex. After noting that these “muscles have been considered vestigial in humans” Liugan *et al.* determined they were very useful for neuroprosthetics purposes, writing:

“... numerous therapeutic and diagnostic wearable devices are designed to monitor and alleviate the symptoms of neurological disorders, brainstem injuries, emotional states, and auditory functions, by making use of the neural networks of the auricular muscles and their locations, which are easily accessible for ergonomic wearable biomedical devices.”<sup>18</sup>

Professor Hackley determined the auricularis posterior muscle response is strongest when people are the happiest.

Another research project studied “Anterior, superior and posterior auricular muscles ... electromyographically by means of wire electrodes. During ear movement the three muscles acted as a group, and the ... highest electrical activities were observed during natural smiling and yawning.”<sup>29</sup> Research on voluntary ear wiggling, smiling, yawning, and other facial gestures has supported the finding presented here that shows the importance of the ear muscles in conveying emotion.

Another study also concluded that many of the small muscles in the head area serve an important role in communication, such as in the elevated startle response as measured by muscle twitching below the eye when the subject is experiencing negative emotions. As noted, the ear muscles are linked to the facial muscles used to pull the mouth into a universally recognized smile. Consciously producing a big grin will cause the ears to retract slightly. Evidence for this finding includes the fact that moving the

“... eyes hard to one side is accompanied by electromyographic (EMG) activity in certain ear muscles. The capture of attention by a novel, unexpected sound emanating from behind and to one side has been found to trigger a weak EMG response in the muscle behind the corresponding ear. ... Reflexive EMG bursts recorded during a selective attention task suggested that subjects were unconsciously attempting to orient their ears toward the relevant sounds.”<sup>30</sup>

Research in this area has just begun, and it illustrates the fact that the verbal communication may say one thing and the nonverbal facial expressions may communicate something very different.

### Summary

The design of the human ear documents that it was not engineered to move, as is true of cats, horses, rabbits, and other animals. Although some people can voluntarily cause



**Figure 2.** The functions of the auricular muscles include their involvement in smiling and yawning.



their ear muscles to contract to produce a slight, from 1–3 mm, movement, these muscles were designed for other purposes besides orienting the pinna towards the source of sound. These other functions include 1) protection of the underlying tissue; 2) the production of heat; 3) to insulate and achieve the required cover in the temporal area of the cranium; 4) to ensure proper development of the ear location; and 5) to communicate emotions, especially smiling. Although the auricular muscles vary in size from individual to individual, they were not designed to produce major ear movements.

Whether a person can wiggle their ears, whether it is learned or involuntary, may be dependent on the details of facial nerve innervation including location, pattern, and extent. The idea that these muscles were designed to move the ear is wrong. These muscles are part of a much larger system that works as a unit to maintain stability and location of the ear, and not move it. Neither the ear nor the muscle system was designed to move, and the only reason this claim was made was based on the evolutionary belief that humans evolved from some animal that early in our evolutionary history could move its pinna towards the source of sound to increase its hearing acuity.

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# The search for Noah and the Flood in ancient Egypt—part 3

Gavin Cox

Scripture describes the territory of Egypt as the “Land of Ham”, and the *Table of Nations* (Genesis 10–11) describes how several of Ham’s descendants settled in Egypt and North Africa. This article asks, because of Ham’s influence, were the Flood survivors’ names—Noah, Ham, Shem and Japheth—known in Ancient Egypt? It is argued here that, along with the memory of the Flood, the sounds and meanings associated with the names of Noah and sons were preserved within the Egyptian language by Ham. I also investigate if their names were deified, and are comparable to the Ogdoad names (eight creator gods represented by four males and their wives, and worshiped at Ashmunein, “Eight City”, associated with the Primal Ocean of Creation)—covered in parts one and two of this series. Parts three and four build on this, presenting evidence *consistent with* these biblical names being understood the same way as Egyptian personal and divine names. Such evidence is consistent with Ham’s influence, and the deification of Noah and sons within Egypt’s polytheistic culture.

## Basic premise of this study

Part three focuses on the name of Ham and will seek to establish the following relationship:

Hebrew Ham (meaning + sound)  $\approx$  Egyptian Ham  
(meaning + sound)  $\approx$  Ogdoad member (religious meaning).

The following discussion will determine how to establish these links, and the meanings of Ham’s name. Firstly, this discussion needs to be placed in biblical context, starting with Babel.

## Ham’s influence on Egyptian language, culture, and religion

Genesis 10 provides a broad historical overview of the settling of post-Babel people groups. Ham had four sons—Mizraim, Phut, Cush, and Canaan—whose territories are associated with Egypt, North Africa (for Phut and Cush) and Canaan, respectively. In three Psalms, Egypt is named after Ham (105:23, 27; 106:22, cf. 78:51), and throughout the Old Testament (OT), Egypt is known by the name of Ham’s son, Mizraim, 588 times. Hence, a strong association between Ham and the land called Egypt (despite Hamitic lineages living elsewhere later).

Ham must have influenced the foundations of the Egyptian language, culture, and religion through his shared experience of surviving the Flood (see figure 1). This may be detected in a shared Flood mythology and onomastics (meanings of names).

Figure 1 illustrates how the Flood survivor Ham influenced Egyptian language, specifically for this study, the sounds and meanings of the names of his father Noah and

his brothers. This study asks did the meanings and sounds of Noah and sons’ names cross over into Egyptian (a post-Babel language) via Ham? It surely would have been expected for Ham to preserve the memory of the names of his father and brothers.

This study analyzes the meanings of Noah, Ham, Shem, and Japheth’s names in the biblical context. Next a search will be made for phonetic equivalents to these biblical names from Egyptian sources and their associated meanings. Lastly, their names will be compared to the Egyptian Ogdoad—the eight creator divinities represented by four males and their wives who were associated with the Egyptian flood called the Nun or Nu.

## The phenomenon of name derivations

In order for a comparison of the meanings of names in both languages, a brief examination of how biblical names were understood and how their meanings were derived is of primary importance. Within Ancient Near East (ANE) cultures (including Egyptian, see below), explanations of proper names, and connecting places, things and events with the signification of names, is a recurring and striking literary phenomenon. Casanowicz<sup>1</sup> exhaustively lists 502 OT examples of ‘paronomasia’ (play-on-words; puns) in alphabetic order, including 22 significant name puns in Genesis. For instance, the Leah and Rachel passages (Genesis 29–30) are a classic example of an ‘extended paronomasia’, involving Jacob’s 12 sons with explanations of each of their birth names.<sup>2</sup> The entire process is repeated, polemically, forming the basis of Jacob’s blessings and curses upon each son—again, based upon the meaning of each name (Genesis 49:1–28).

Hallo cites Garsie, who has collected ‘literally hundreds’ of examples of implicit etymologies in the Bible, calling them

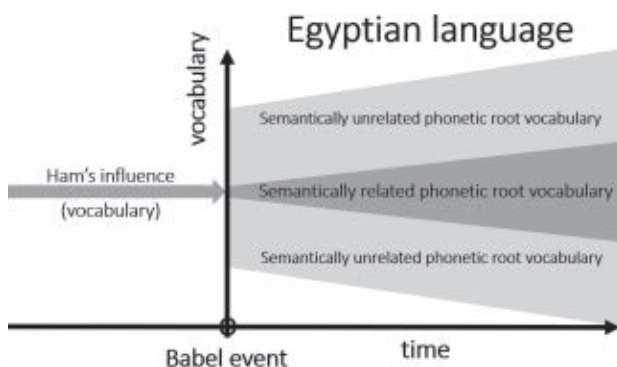


Figure 1. Influence of Ham on Egyptian language (vocabulary)

‘Midrashic Name Derivations’ (MNDs) which are not ‘scientific etymologies’, but none-the-less were comprehended by those who gave or received names, or who read the Hebrew text.<sup>3</sup> Krašovek lists 50 examples of naming etymologies from Genesis and states:

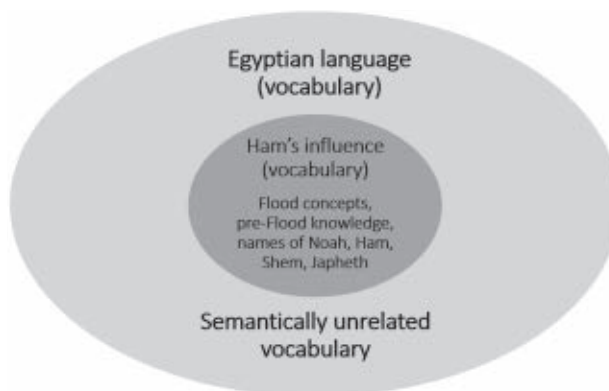
“The book of Genesis is the richest source of examples in which the naming of a place or person is followed by an etymological explanation of the naming, or at least allusion to etymological meaning of the naming: Eve (3:20), Cain (4:1), Seth (4:25), Noah (5:29) [etc.] ...”<sup>4</sup>

Casanowicz states this kind of naming practice prevailed in various times, cultures, and languages. Both Semites and Greeks paid great attention to sounds and significations of names, which possessed “solemn and religious significance for them”.<sup>5</sup>

Casanowicz cites Brugsch, who recognized that Egyptian mythological writings also expound “theological names and expressions ... frequently [and] catch-words of myths [function in linguistic and etymological ways, in order to] prove their contents from their form and signification”.<sup>5</sup>

In summary, the evidence demonstrates great significance was held for meanings and derivations of names to those who gave them and those who received them, both in biblical and ANE literature. Typically, the immediate surrounding text offers readers the context by which names are understood, via phonetic markers or allusions within the literary context.

For this study, the meanings of Noah and sons’ names are derived from phonetic and semantic connections (meanings of words) within the biblical text. Within Scripture at a fundamental level, the prophetic pronouncements of Noah to his sons were comprehended because of shared language and experience. Noah’s family knew what their names meant, in the way similar-sounding words of specific meanings were drawn upon. Were these phonetic and semantic connections passed on from Ham into the Egyptian language? Is there evidence that these biblical names were comprehended by Egyptians in the same way?



### Noah and sons’ names—not equivalent to mythological ANE flood heroes

For more than a century, liberal biblical scholars maintained that ‘anonymous editors’ of Genesis borrowed their source material for the Flood account from ANE myth, specifically the 7<sup>th</sup> century BC *Gilgamesh Epic*. This theory forms part of the *Documentary Hypothesis (DH)*, published in 1883 by Karl Heinrich Graf and Julius Wellhausen. If their DH were correct, among other objections, why aren’t Noah and sons’ names discernible within *Gilgamesh*—whose Flood hero is called ‘Utnapishtim’ (Tablet 11)? In another Babylonian version (1966 BC) he is called ‘Atra-Hasis’. A Sumerian tablet (c. 2100 BC) names the hero as ‘Ziusudra’,<sup>6</sup> and a Chaldean account (660 BC) names him ‘Sisit’.<sup>7</sup>

A common theme throughout these ANE accounts is that the Flood hero is named, but his family remains anonymous. The DH has singularly failed to demonstrate that the names of Noah and sons derive from ANE flood mythology. Only the Bible preserves the inerrant history of the Flood, along with the names of the Flood survivors. Ham, in some measure, would also have preserved the memory of the Flood, his father and his brothers in terms of their names and what they meant. Noah’s family, as real people and founding figures of civilization, must have left discernible cultural and linguistic footprints in history, which for this study will involve the analysis of Egyptian names and vocabulary.

Liberal scholarship, blinded by the secular presuppositions of the DH, would not seek evidence in ancient Egypt for links to Noah and sons, having denied their existence in all but myth.<sup>8</sup> However, the fundamental presupposition advanced by this study is that the inerrant Genesis record represents true history. The working hypothesis is that the ancient Egyptians knew the names of the Flood patriarchs via Ham who then deified them. Based on this premise, four research questions are set out below:



Do Noah and sons have ‘sound-alike’ personal names in Egypt?

The sounds and meanings of Noah and sons’ names were faithfully preserved, along with the pre- and post-Flood history. These were finally collected and edited by Moses, under Divine Inspiration, into the first book of the Bible, called Genesis. Because of Ham’s influence on Egypt, this study asks, how should the original biblical names of Noah and sons be compared to Egyptian names? It must be recognized that Noah and sons’ names—familiar to us from our English Bibles—have been ‘anglicised’. Furthermore, some Hebrew sounds are not directly equivalent to Egyptian sounds. This is relevant when it comes to comparing vowels, as modern scholarship does not know how most Egyptian vowels were vocalised (which typically were not annotated within hieroglyphic script). Egyptologists standardise Egyptian vowels with an ‘e’ for convenience within transliteration convention.<sup>9</sup> It is also needful to consider how certain consonants are understood as being equivalent between Egyptian and Hebrew. To these ends, each biblical name will be assessed phonetically (i.e. the spoken sounds of words).

A standard work on Egyptian linguistics by Antonio Loprieno<sup>9</sup> will inform the Egyptian phonetic considerations of this study—which will necessitate the use of technical notation to describe phonetic sounds. Nevertheless, when it comes to the sounds of the biblical names of Noah and sons we can be confident these were preserved in Scripture, which included the trained editorial hand of Moses.

#### Determining meaning—‘semantic range’

An accurate understanding of Noah and sons’ Hebrew names must first be established in order to determine whether they have equivalent meanings to Egyptian names—that sound the same (phonetic counterparts). This will be done by comparing the Hebrew roots, associated with their names to similar-sounding Hebrew words within the biblical text. Supplemented with Hebrew lexicons,<sup>10</sup> semantic connections with these names can be established—a standard method employed by biblical commentators.<sup>11</sup> The semantic (or lexical) range can be defined as a set of words grouped by meaning that refer to a specific subject—in the case of this study, the meaning of Noah and sons’ names. This study will determine if ‘sound-a-like’ Egyptian names share the same meaning as the names of the Flood patriarchs. Sounds of words in both Hebrew and Egyptian are expressed by the consonants that make up words. The ‘sibilant’ core structure of any given word is called a ‘root’. Leprieno defines the Egyptian root thus:

“The basic structure of an Egyptian word is a lexical root, an abstract phonological entity consisting of a sequence of consonants or semiconsonants which vary in number from one to four with an overwhelming majority of biconsonantal and triconsonantal

[examples]... ”<sup>12</sup>

Simply put, if these names and associated vocabulary sound the same and mean the same, then a linguistic connection can be claimed between the biblical Hebrew names and any potential Egyptian counterpart. However, it must be considered that the human vocal system is capable of producing a wide range of sounds, so these phonemes will occur in different languages, but will obviously carry different meaning. Figure 1 predicts Ham’s influence upon the Egyptian language in terms of the names of Noah and sons and their semantic meanings. Conversely, phonetically equivalent-sounding words bearing no semantic relationship to the original spoken language of Noah’s family are expected from the de novo creation of the new post-Babel language.

#### Do Egyptian personal names occur as divine names?

The next question asked is, do these personal names occur as divine names? This question stems from the likelihood that Noah and his family were worshipped. Specifically, the phenomenon of ancestor worship is well known within Egyptian scholarship.<sup>13</sup> Such a prospect arises when the Flood survivors’ immense lifespans are considered. Furthermore, they were sole survivors of the Flood, and possessed the sum total of human knowledge of both pre- and post-Flood worlds. Within the polytheistic thinking of the ancient Egyptians, such privilege necessarily conferred on Noah’s family a guaranteed divine status.<sup>14</sup> If Noah and family were worshipped as divine ancestors in Egypt, these ‘sound-alike’ Egyptian personal names would naturally transfer to divine names—including the Ogdoad.

#### Are these names equivalent in meaning to the Ogdoad names?

Lastly, the meanings of Noah and sons’ names will be compared to the Ogdoad names. The Ogdoad names are Nu, Amun, Kek, and Heh, and the female names are simply the feminine form of the male names. The meanings were established in parts 1 and 2 of this study, and are well known within Egyptian scholarship. Do the names of Noah and sons share the same meanings as the Ogdoad names? If this can be established, *then* it greatly strengthens the hypothesis that these gods are the polytheistic version of Noah’s family.

### Methodological caution

The methodological control employed in this study is to: 1) Stay as close to the Hebrew meanings of the names of Noah and sons and their phonetic sounds as possible, compared to any Egyptian counterparts; and 2) The oldest examples of Egyptian names and vocabulary are considered most significant.

To investigate whether Noah and sons’ names occur in Egyptian onomastics, Egyptian lexicons<sup>15</sup> and a modern scholarly internet database, *Thesaurus Linguae Aegyptiae*

**Table 1.** Representatives of *hm/hm/km/hm* personal and divine names. (OK = Old Kingdom, MK = Middle Kingdom, NK = New Kingdom).

RPN#	personal name	Hieroglyph	date
I, 240.7	<i>hm</i>		OK
I, 233.14	<i>hꜥm</i>		OK
I, 229.16	<i>hmnn</i>		OK?
I, 344.27	<i>km</i> (also <i>km.t</i> )		MK
I, 269.13	<i>hm</i>		MK
Wörterbuch#	divine name	hieroglyph	date
III, 82.2	<i>hm.i</i> ("sky god")		OK
IV, 881	<i>hm</i>		NK
V, 125.4	<i>km.t</i>		MK
III, 280.16	<i>hm</i>		MK

(*TLA*), were used to search for names and vocabulary that are close phonetic matches to Noah and sons' names. Because Egyptian vocabulary is vast, it could be charged that there will always be some likelihood of contriving connections. This article has no way to prove or disprove this charge—statistically. However, what is offered is evidence *consistent with* the names of the Flood survivors being known in ancient Egypt, and being equivalent to divine and Ogdoad names. It will be a matter of opposing views as to whether the evidence is considered merely a statistical artefact of a large data set,

or evidence of the linguistic influence of historical people.

### Introducing *Thesaurus Linguae Aegyptiae* (*TLA*)

The online *TLA* search engine (figure 2) currently accesses approximately 1,400,000 words,<sup>16</sup> including the *Wörterbuch der Aegyptischen Sprache*, and other scholarly standard lexicons. This is a modern computer database resource used by Egyptology researchers and provides the ability to sift through huge datasets of vocabulary quickly. Results are linked to original, dated primary source material.

The *TLA* supplemented with Egyptian lexicons was used to test for close phonetic and semantic matches of Egyptian names and vocabulary compared to the Hebrew names of Noah and sons. The following discussion analyses the results of these database

text searches. Transliteration convention is required for *TLA* text searches,<sup>17</sup> specifically, the *Manuel de Codage*<sup>18</sup> (*MdC*) where the following relevant phonemes are coded thus: (*h, h, h, h, s, s, s = H, h, x, X, S, z, s*).<sup>19</sup>

### First test case: Ham—an Egyptian-sounding name

It is appropriate to start this investigation by comparing the Hebrew understanding of the phonetic sound and meaning of Ham's biblical name, compared to any Egyptian

**Figure 2.** Online *Thesaurus Linguae Aegyptiae* (*TLA*) search engine

counterparts that may exist. Ham will be the first test case in order to assess the method outlined above. The Hebrew name Ham (חַם) is pronounced *hām*. The initial ‘pharyngeal fricative’ <ħ> is grouped with the guttural fricatives: <ħ>, <ħ>, <ħ>. Phonetically similar ‘voiceless stops’ /k/ and /kʰ/ coexisted in Egyptian, and survived into Coptic—for instance **ⲕⲙⲙⲉ** and **ⲕⲙⲙⲓ** represent two forms of *km.t* (‘Egypt’).<sup>20</sup> Egyptian lexicons were consulted for the following group of related phonemes to see if they occur as personal and divine names equivalent to biblical Ham. The following results are offered as representative examples (table 1).

#### Discussion of results

RPN lexicon records: 2 *hm*, 44 *hm*, 14 *hm*, 0 *hm*, and 33 *km*, variant personal names. LGG lexicon records: 230 *hm*, 13 *hm*, 100 *hm*, 2 *hm*, and 47 *km* variant divine names. Table 1.1 offers representative examples of *hm/hm/km/hm* personal and divine names ranging from OK to NK, demonstrating these names are common, ancient, and consistent with Egypt being founded by Ham as per biblical testimony.

#### Ham: meaning of the biblical name Genesis 6:10–11

וַיֹּלֶד נֹחַ שְׁלֹשָׁה בָנִים אֶת־שֵׁם אֶת־חָם וְאֶת־יָפֶת׃<sup>10</sup>

וַיִּמְלֵא הָאָרֶץ חָמָס׃<sup>11</sup>

“And Noah begat three sons, Shem, Ham (*hām*), and Japheth ... and the earth was filled with violence (*hāmās*)” (Genesis 6:10–11).

At Genesis 6:11 the reason for the Flood is given, because the earth is full of ‘violence, wrong’ *hāmas*, (HALOT-2980)—the first occurrence of this word in Scripture. A phonetic correspondence with the name ‘Ham’ is apparent in vs. 11 (note grey-highlighted Hebrew text). Garsiel states: “The pun ... does not serve here merely as sound play but implies a connection between Ham and ‘lawlessness’. Later on (9:22–27), this son indeed displays the inferiority of his nature compared to his brothers.”<sup>21</sup>

Table 2 lists Hebrew words that share their phonetic root with the name Ham. Each word is the first occurrence in Scripture, thereby offering a minimum semantic range.

#### Is the meaning of Hebrew Ham the same as Egyptian ‘Ham’?

Table 3 lists related Egyptian words containing phonetically equivalent *km/hm/hm/hm* roots. It is offered as evidence consistent with the Egyptians’ understanding these

**Table 2.** Theoretical semantic range for the name ‘Ham’

TWOT#	translit.	translation	ref.	first biblical example
0678/a	<i>hāmas</i>	“wrong, do violence to, treat violently”	Genesis 6:11, 13	“... the earth was filled with violence (חָמָס).”
				<b>theoretical lexical field</b>
677a–c	<i>ham</i>	“heat, be hot, warm”	Genesis 8:22	“... While the earth remains ... cold and heat (חֶמֶד), summer and winter ... shall not cease.”
625a	<i>hūm</i>	“darkened, dark brown or black”	Genesis 30:32	“... every speckled and spotted sheep and every black (חֹמֶם) lamb ... shall be my wages.”
507	<i>hom</i>	“break, consume, crush, vex, destroy, discomfit, trouble”	Exodus 14:24	“... the LORD looked ... and troubled (חָמָה) ... the Egyptians.”
505	<i>hāmū</i>	“loud, mourn, rage, roar, sound, make noise, tumult”	Psalms 46:6	“... The heathen raged (חָמָה) ...”

phonetically equivalent names in the same way as biblical Ham was understood.

#### Discussion of results

From the TLA a search returned the following vocabulary listed here by phonetic root: *km* – 29; *hm* – 10; *hm* – 41; *hm* – 116 words. Table 3 lists all root words discovered, that share meaning with biblical Ham. (Theoretically representing the influence of Ham himself, see figure 1.3). The closest phonetic equivalent root to Hebrew Ham (*hm*), surprisingly, demonstrates only two semantic connections. However, vocabulary containing the phonetic roots *hm*, *hm*, *km*, demonstrate strong semantic connections with biblical ‘Ham’. The semantic range is spread across these three specific aspirated stops from OK to NK. It should be noted that the word ‘violence’ (*hmt*) has been imported back into Egyptian from Semitic (*hāmas*), by the time of the MK, demonstrating a semantic link already existed, which from the evidence in table 2 suggests points back to the OK.

Figure 3 represents the minimal biblical semantic range for the name ‘Ham’, alongside the lexical fields for vocabulary with phonetically similar roots. The Egyptian lexicons reveal 196 words which are mostly unrelated to the lexical field for biblical Ham. However, Egyptian words that are semantically equivalent, with equivalent phonetic sounds can theoretically represent the influence of Ham on the Egyptian language.

From the evidence presented here, phonetically similar Egyptian names (*hm*, *hm*, *km*) when compared with biblical



**Table 3.** Comparing Hebrew and Egyptian vocabulary containing *hm/hm/km/* roots

Wörterbuch#	Egyptian	translit.	translation	date
III, 281.1–4; (CT II, 117n)		<i>hmj; hmm</i>	"destroy, overturn, attack, destroyer"	OK
III, 281.5; 285.13		<i>hmt; hmj.w</i>	"power (?), violent act (?)" (Sem. loan word), evil"	MK
III, 96.9–10		<i>hms</i>	"to slay, to slaughter"	MK
II, 490.9–17, 491.2–5, 5–6; V, 130.5.		<i>hmhm; hm; km</i>	"roar, to rumble, war-cry, lament"	OK; MK; NK
V, 122–124.5;		<i>km, kmm</i>	"black, dark"	OK (PT)
I, 345.4; VI, 536.13		<i>whm</i>	"charcoal"	NK
II, 489.15–16		<i>hm</i>	"to burn, to be hot"	NK
V, 122.7; 127.4–127.17; 127.18–20; (LGG VII, 284)		<i>km.t; km.ti</i>	"crown of Lower Egypt, Egypt, Egyptians"	MK; OK

Ham, share semantic connections, offering evidence consistent with these names being influenced by Ham and understood in the same way the biblical Ham was understood.

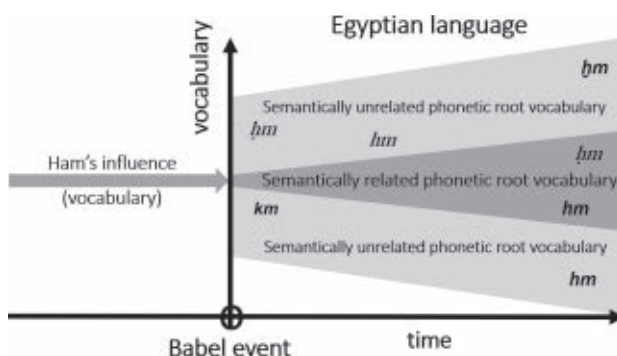
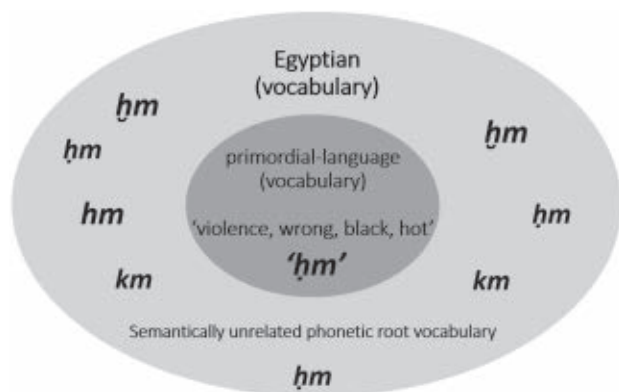
### Biblical Ham corresponds to a member of the Ogdoad

As has previously been discussed in parts 1 and 2 of this series,<sup>22,23</sup> inscribed within cartouches written above the

heads of the Ogdoad are their names, the meanings of which are firmly established by Egyptian scholarship. To investigate if there are correspondences to the biblical name of Ham with a member of the Ogdoad, the most appropriate Ogdoad name will be investigated to see if it shares an equivalent semantic field comparable to biblical Ham. As is already known, Ogdoad member Kek means 'darkness',<sup>24</sup> which corresponds, in part, semantically to the Hebrew name Ham and Egyptian phonetic roots which convey concepts of 'darkness', 'dark colour', and 'black'. Table 4 lists vocabulary containing the root 'kk' in order to see if there are further correspondences.

### Discussion of results

The comparison between biblical Ham and Kek demonstrates shared concepts 'aggression', 'noise', and 'darkness' (but not 'hot') occurring in the OK. Kek also shares a significant connection with Ham—being a toponym for Egypt: *kk.t* appears on the Tuthmosis list at Karnak referring to Middle Nubia, which was the seat of one of the earliest civilizations of ancient Africa—a parallel concept to Ham naming the land of Egypt. Kek appears as a personal name dating from the OK (Gisa, Central Field), of which 16 variants are recorded, and 10 divine name variants—including Ogdoad member Kek. There are therefore significant parallels between the biblical name Ham and Egyptian Kek, thereby offering evidence consistent with Ham being deified as Kek within the Ogdoad.

**Figure 3.** Influence of Ham on Egyptian language

### Representative text examples sharing km/kk phonetic roots in context

Listed below are examples of Egyptian inscriptions that reveal in context the occurrence of root words associated with *km* and *kk*. The inscriptions chosen are to represent key vocabulary associated with the meaning of Ham's name, and the Ogdoad member theoretically linked with his name—Kek. (Hypertext links are accessible after log-in; username and password 'user' are sufficient to get past login-screen.)

NK. Papyrus of Nu, Tubingen 134, line 8.

*hmi.yw hmi, yt hmi.t (j) = sn m wsjr —NN— m3c-hrw m wj3 n jti = f r<sup>c</sup>, w*

"The **invaders** and **attackers** who ought to ostracize Osiris NN in the bark of his father Re."

OK. Deir el-Gebrawi, tomb of Henqu II, east wall, middle register, large inscription, line 21.

*hm (hm) = j s n wsr = j r = f šjwi = f hr*

"I've never **roared** at a man (**warlike**) because I'm stronger than him ..."

OK. Saqqara, Teti Cemetery, Nicausesi's mausoleum, Mastaba of Nikauisesi, facade, door reveal, right soffit, line 11.

*s3 = f šmś w mry = f šmr-w<sup>c</sup>.t (j) n (j) -k3 (Ni-k<sup>c</sup>u-Teti) km šmśw*

"His eldest son, his lover, the only friend Ni-kau-Teti, the **dark-skinned** and the elderly."

18<sup>th</sup> Dyn. Papyrus of Nu, BM EA 10477, line 108.

*jm.j hm = f rn = f*

"The one with his **fever** [hot] is her ... name."

MK. Papyrus Berlin P 10499, Recto: *The Eloquent Peasant*, version R, line 1,3.

*m = t w j m h3i.t r km.t r b jni b.t c<sup>q</sup>.w jm n hrd.w = j*

"Behold, I am going down to **Egypt** to fetch / buy food for my children."

Text examples for *Kek*

OK. Pyramid of Teti, PT 362, line 605a-b.

*jt (j) n (j) ttj m kk.w jt (j) n (j) ttj (j) tm (.w) m kk.w*

"Father of Teti in the **dark!** Father of Teti, Atum in the **dark!**"

Ptolemaic. Karnak, Opetempel, central hall (VII), south wall, 3rd register, 2nd stage (above door 'S').

*dd-mdw jn kk (.w); di = j n = k h<sup>c</sup> = k mj r<sup>c</sup>; dd-mdw jn kk.t; di = j mn rn = k hr-š3 t3*

"Lyrics spoken by **Kekou**; I give you your appearance, like Re. Lyrics spoken by **Keket**; I make your name be established on Earth." (Note: Kekou/ Keket are from the Ogdoad).

Ptolemaic. Karnak, Opet Temple, outer-east walls, basement, first reg. south.

*(kysrs) hr = k jni = f n = k hapj kk.w*

"Caesar, came near you to bring you the flood, the water **Kekou**."

OK. Unas pyramid, PT 292, line 544.

*nk tkk.n tk, j jkn-hj (.w)*

"You're one the **attacker** attacked"

### Summary

From the linguistic evidence discussed in this article, the following comparison can be made:

Hebrew Ham (violence, dark) ≈ Egyptian Ham (violence, dark) ≈ Ogdoad member Kek/Kek.t (violence, dark).

The evidence is consistent with biblical Ham being understood in the same way as these Egyptian personal and divine names. They are phonetically equivalent to Hebrew Ham, and

**Table 4.** Egyptian vocabulary with phonetic roots for 'Kek'

Wörterbuch#	Egyptian	translit.	translation	date
V, 336.2–11		<i>tkk</i>	"attacker, aggression, violator, injure"	OK
(DNG, V, 209.5.)		<i>kkt</i>	"Middle Nubia"	NK
V, 142–143.15		<i>kk.w</i>	"darkness, twilight, gloom"	OK (Saqqara)
V, 144.13; (LGG VII, 296); (RPN I 348–349)		<i>kk.w; kk.t</i>	"Kek, Keket, divine names, personal names"	Ptol.; OK
V, 144.15		<i>kk.w</i>	"flood waters"	Ptol.

share an equivalent semantic range. These names transfer to divine names, a late flood epithet, and can successfully be compared to Kek and Kek.t, a divine pair from the Ogdoad, offering strong evidence consistent with Ham influencing Egyptian names, vocabulary, and becoming a deified Egyptian ancestor.

## Conclusion

Part 3 in this series, investigating the evidence for Noah and the Flood in ancient Egypt, has focused on a study of Ham's name. A series of four research questions has been laid out that structure the linguistic exploration of Hebrew and Egyptian onomastic sharing. First, how are the Flood patriarchal names understood in biblical context? Through the well-known linguistic phenomenon of paronomasia (punning), meanings of names can be derived from phonetic keys in the immediate biblical text. Scripture contextually links Ham's name with 'lawlessness/violence'. The context of this pronouncement is derived semantically from phonetic connections within the speech unit itself (Genesis 6:10–11), whereby a pun is made upon relevant vocabulary that bears phonetic similarities to the name under consideration. The next question asked is do phonetic counterparts of the name Ham occur as Egyptian personal and divine names? This has strongly been answered in the affirmative, with the following examples of phonetically equivalent personal and divine names—*hm*, *hm*, *hm*, and *km*. It has been shown that several of these names share an equivalent semantic range compared to biblical Ham. Finally, a name of the Ogdoad was tested with the same method to reveal linguistic connections between biblical Ham and the Ogdoad couple Kek and Keket.

Data has been presented consistent with the hypothesis that the biblical name Ham and phonetically equivalent Egyptian names were similarly understood. Such connections are consistent with the influence of Ham as the founder of Egypt and that Ham became a deified ancestor.

Part 4 of this series continues with the method outlined above to analyse the names of Noah, Japheth, and Shem. Evidence will be offered that is consistent with these names existing as personal and divine names in Ancient Egypt, with equivalent meaning and that they are comparable to the Ogdoad names, representing the polytheistic deification of Noah's family. The implications of which corroborate biblical history.

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# The search for Noah and the Flood in ancient Egypt—part 4

Gavin Cox

It is reasonable to assume Ham took with him into Egypt the names and knowledge of Noah's family and their first-hand experience of the Flood. Part 4 of this series asks, were the names of the Flood survivors Noah, Japheth, and Shem known in Ancient Egypt? And can they be successfully compared to the names of the Ogdoad? Parts 1 and 2 of this series began to establish this, focusing in part 3 on Ham as the first test case. Building on this evidence, part 4 demonstrates that Noah, Japheth, and Shem are comparable to ancient Egyptian personal and divine names. Furthermore, comparisons of these Flood patriarchal names with the Ogdoad reveal linguistic connections supporting the hypothesis of Noah and sons' deification within Egypt's polytheistic culture.

## Basic premise of this study

It is well known within Egyptian scholarship that pharaohs, priests, and ancestors were apt to be deified and worshipped by the Egyptians. Imhotep, the 3<sup>rd</sup> Dynasty priest, architect of Djoser's step pyramid, is the parade example of a man who became a god.<sup>1</sup> This study will focus on the names of Noah, Japheth, and Shem, which were likely deified via Ham's influence. I will seek to establish the following relationships between their names and Egyptian personal and divine names and the Ogdoad:

Hebrew Noah (sound + meaning)  $\approx$  Egyptian 'Nu'  
(sound + meaning)  $\approx$  Ogdoad member (equivalent  
religious meaning).

Hebrew Japheth (sound + meaning)  $\approx$  Egyptian  
'Japheth' (sound + meaning)  $\approx$  Ogdoad member  
(equivalent religious meaning).

Hebrew Shem (sound + meaning)  $\approx$  Egyptian 'Shem'  
(sound + meaning)  $\approx$  Ogdoad member (equivalent  
religious meaning).

## Second test case: Noah—an Egyptian-sounding name?

The Egyptian lexicons were consulted in order to discover the nearest phonetic equivalent personal names to Hebrew Noah (נֹחַ). The following phonetic considerations are taken into account in order to narrow down word search parameters by considering what sounds are equivalent in Egyptian and Hebrew. Loprieno points out that 'dental consonants' such as "Afroasiatic [Hamito-Semitic] \*n were kept as Egyptian /n/,"<sup>2</sup> and the Coptic ⲛ,<sup>3</sup> is a descendant of this strong consonant. The Hebrew vowels pointed in the MT

as  $\bar{o}^a$  correspond to Egyptian vowels /w/ and /u/ (It should be noted that  $w = u$  within different conventions of transliteration). The 'terminal voiceless pharyngeal fricative' ( $h$ ) of Hebrew Noah is expressed as Egyptian /h/. From these phonetic considerations, constraints to the following search phonemes are applied and used as test cases: specifically, the tri-consonantal root  $nwh$  and its fundamental bi-consonantal root  $nw$ .<sup>4</sup> The following data was retrieved from Egyptian Lexicons as representative examples in table 1.

## Discussion of results

From the lexicons, 18 personal and 146 divine names, prefixed by the bi-consonantal root 'nw' were counted, examples of which are in table 3. These names occur as early as the OK Pyramid Texts (PT). 10 examples of exact phonetic equivalent names compared to Hebrew Noah, 'nwh', which were found typically prefix to divine epithets, dating from the 6<sup>th</sup> Dynasty. A similar name,  $nwy$ , occurs in the 6<sup>th</sup> Dynasty, PT-1525. Most Nu names lack the fricative 'h' that Hebrew Noah possesses, a phenomenon also observed in Greek (Νῶε). Nu is the nearest common bi-consonantal phonetic Egyptian name comparable to Hebrew Noah.

## Noah: meaning of the biblical name

The biblical text is our first port of call to comprehend the meaning of 'Noah', which is derived from phonetic clues within the Flood narrative. Garsiel states:

"Scholars have noted that a variety of [midrashic name derivations, MNDs] are attached to the name of Noah in the story of the Flood [establishing the meaning of Noah's name]".<sup>5</sup>

Within the Flood narrative, Noah's name is reflected on at key stages, a phenomenon commented on by Umberto

**Table 1.** Noah ‘sound-alike’ personal and divine names

RPN#	Personal Name	Hieroglyph	Date
I, 182.20	<i>nw</i>		OK (6th Dyn. Giza)
I, 182.25	<i>nwi</i>		OK (6th Dyn. Saqqara)
I, 206.7	<i>nwnw</i>		OK (5th Dyn. Saqqara)
I, 182.29	<i>nwh-k3.w</i>		OK (6th Dyn. Saqqara)
Wörterbuch#	Divine Name	Hieroglyph	Date
II, 215.15–16	<i>nw.w.wr</i> ("The great Nun")		Roman
II, 215.19	<i>nwy</i>		OK (PT 1525)
II, 215.5–6	<i>nw.w</i>		OK (PT)
II, 218.18	<i>nw</i>		NK

Cassuto, which he termed an “extended paronomasia” (play-on-words).<sup>6</sup> Polak states:

“The name Noah, then, stands at the centre of a broad set of similar vocables which permeate the entire Flood tale.”<sup>7</sup>

The key texts in the Genesis narrative that are significant to this point are the following 5 passages:

וַיִּקְרָא אֶת־שְׁמוֹ נֹחַ לֵאמֹר זֶה יִנְחָמנוּ מֵעֲשָׂנוּ ...

“Lamech ... called his name Noah (*nōḥ*), saying, ‘This same shall comfort (*naḥām*) us concerning our work ...’” (Genesis 5:29).

וַיִּנְחָם יְהוָה אֶת־הָאָדָם בְּאָרְץ ...

“...it repented (*nāḥem*) the LORD that he had made man on the earth ...” (Genesis 6:6).

וַיִּנְחָה הַתֵּבָהּ ... עַל הָרִי

“... the ark rested (*naḥ*) on the mountains ...” (Genesis 8:4).

וְלֹא־מָצְאָהּ הַיּוֹנָה מְנוּחַ לְכַף־רַגְלָהּ ...

“... the dove (*yōnāḥ*) found no rest (*mānōḥ*) for the sole of her foot ...” (Genesis 8:9).

וַיִּבְרַח יְהוָה אֶת־רִיחַ הַנִּיחֹם ... וַיִּבְרַח נֹחַ מִזֶּבֶחַ

“Noah (*nōḥ*) built an altar ... the LORD smelled a sweet savour (*nīḥōḥ*) ...” (Genesis 8:20–21).

Within Lamech’s prophetic naming speech of Noah (Genesis 5:29) *naḥām* (a piel imperfect) is utilized, demonstrating Lamech drew upon the ‘comfort/ restful’ aspect of the verb’s root. This is repeatedly observed in the direction of the Flood narrative paronomasia: “the ark rested”, “the dove found no rest” and YHWH smelled a “sweet savour”. (*BDB-5967* translates *nīḥōḥ* as “soothing, tranquillizing odour of sacrifices acceptable to God”—thereby

causing YHWH to rest from his work of judgment. At Genesis 6:6 the niphal imperfect (*nāḥem*) is drawn upon to indicate YHWH’s ‘sorrow’ for creating humanity. (*BDB-6037* translates this as “be sorry, moved to pity, have compassion ... [by extension care for]”).

The biblical text provides the semantic range for understanding Noah’s name. *TWOT-1323f* commentary on the etymology of Noah’s name is noteworthy:

“Our root [shared with Noah] signifies not only absence of movement but being settled in a particular place ... *mānōaḥ*, resting place ... This noun denotes a place of *nūaḥ* (motionless, security) for animals or people, i.e. a place to settle down, a home.”

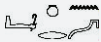






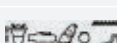

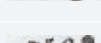



With these biblical concepts in mind, table 2 tabulates the biblical semantic range for ‘Noah’. *TWOT* lists 5 words related by root, see table 2.

Having established the semantic range for Noah’s name, Egyptian words of equivalent meaning and sound (semantic

**Table 2.** Noah’s semantic range, by phonetic root

TWOT#	Translit.	Translation	Ref.	Text Example
1344	<i>nāḥām</i>	“be sorry, repent, regret, be comforted, comfort” [care for]	Gen. 6:6	“And it repented (נָחַם) the LORD that he had made man on the earth ...”
1322b	<i>nāweh</i>	“dwelling, abiding”	Exo. 15:13	“guided them ... unto thy holy habitation (נֹחָה) ...”
1323c	<i>nīḥōaḥ</i>	“quieting, soothing, soothing aroma”	Gen. 8:21	“... the LORD smelled a sweet savour (נִיחֹחַ) ...”
1323f	<i>naḥ</i>	“resting place, rest”	Gen. 8:4	“And the ark rested (נָחָה) in the seventh month ...”
854a	<i>yōnāḥ</i>	“dove, pigeon”	Gen. 8:9	“... the dove (יֹנָתָן) found no rest ...”

**Table 3.** Egyptian vocabulary containing phonetic ‘nw’ root words

Wörterbuch#	Egyptian	Translit.	Translation	Date
(RPN II, 182.20)		<i>nw</i>	(assumed root of the following)	
II, 223.4		<i>nwr</i>	“Creator’s concern for the world”	OK
II, 220.5–14		<i>nwi</i>	“take care of”	OK
III, 369.16–370.14		<i>h̄nw</i>	“place of residence”	OK
III, 373.5		<i>h̄nw</i>	“home affairs; place of residence; (inner)”	OK
III, 287.3–288.3		<i>h̄ni</i>	“settle down; alight; stop; rest”	OK
II, 275.2–8		<i>nni</i>	“be weary; be inert; to subside”	OK
II, 15.5–6		<i>nw.w; nn.w</i>	“Nu/Nun (divine name)”	OK
II, 226.1–5		<i>nwd</i>	“an aromatic ointment”	OK
II, 2, 275.9–12; II, 203.2		<i>nnw;</i> <i>niwy</i>	“weariness, inertness, tiredness” “to come to rest (the Flood)”	MK Ptol.
III, 288.12–15		<i>h̄nw</i>	“resting place, abode”	SIP
II, 69.8		<i>mn.w</i>	“abode”	OK
II, 79.3–5		<i>mnw.t</i>	“dove, pigeon”	OK
II, 214.18–215.4		<i>nw.w; nn.w</i>	“primeval waters”	OK

and phonetic counterparts) were searched for in *TLA*. Table 3 lists the results of this search.

#### Discussion of results

A *TLA* search for words containing *nw* phonetic roots was made, returning 116 words. Table 3 lists 17 words, equivalent to the Genesis Flood extended paronomasia vocabulary. The phonetic root *nw* (symbolized by the N35 ‘water ripple’ and W24 ‘nu pot’) was taken as the bi-consonantal root, or nearest phonetic equivalent. Of these, 13 words date from the OK, and 4 from MK and later. The *TLA* data presented in table 3 reveals strong phonetic and semantic connections with the semantic range of Noah’s biblical name. Particularly noteworthy are OK Egyptian parallels to the Hebrew piel imperfect verb ‘consolation/sorrow’ (*naḥām*) drawn upon by Lamech’s naming of Noah in Genesis 5:29; and 6:6 niphal imperfect (*nāḥem*) describing YHWH’s ‘sorrow/repentance’ for creating humanity. A strikingly equivalent concept occurs in OK ‘*nwr*’, translated “Creator’s concern

for the world” (*Wb* II, 223.4), and OK ‘*nwi*’, “take care of” (*Wb* II, 220.5–14). Furthermore, the ‘restful’ and ‘homely’ aspects inherent in Noah’s name are reflected in OK *nni*, *h̄ni*, and *mn.w* meaning ‘resting place’, ‘rest’, and ‘abode’. Notably, the *Egyptian Wörterbuch* translates *niwy* “to come to rest (referring to the Flood)” (*Wb* II, 203.2).

Table 3 offers words directly equivalent to, or which share equivalent meanings with, ‘Noah’, spread across OK to later dates. The OK divine name Nu is the chief male deity of the Ogdoad—the group of eight gods discussed in parts 1–3, whom the Egyptians believed emerged from the Primeval Flood, itself named *nw* and *nn*.

Representative OK text examples sharing *nw* roots in context

Listed below are five representative Egyptian texts that reveal, in context, how root words associated with *nw* are used (many more could be cited). The examples chosen represent key vocabulary associated with the meaning of Noah’s name, and the Ogdoad member whose name possesses the



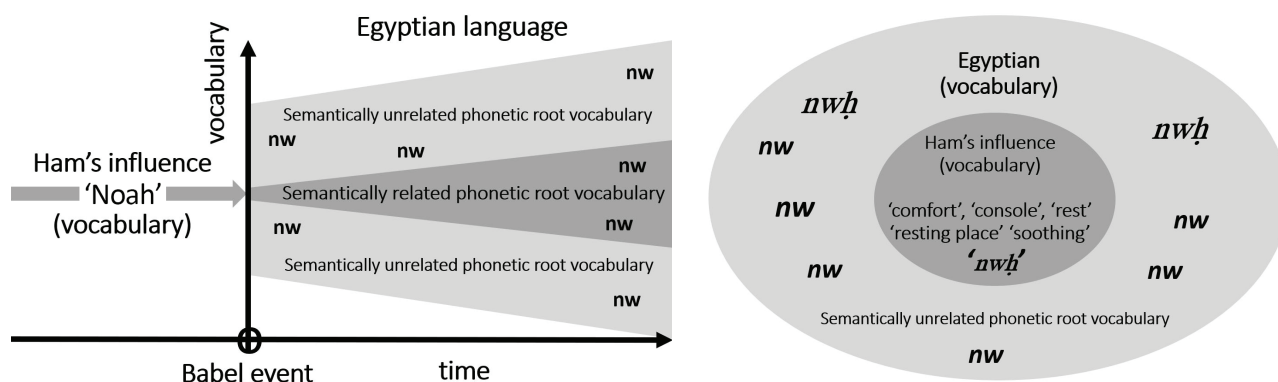


Figure 1. Influence of Ham on Egyptian language (vocabulary)

phonetic root *nw*. (Hypertext links are accessible after login—username and password ‘user’ are sufficient to get past login-screen).

MK. Inscription of Sesostri I, Month-temple of El-Tod, col. 7.

... *wbn m sb3 wʕ, tj ḥr = s ḥr wn (n) ḥr nw, t t3 pn*

“... the one who rises as a lonely star with them ... while being **full of concern** for this land.”<sup>8</sup>

c. 518 bc, Darius I. Hybis Temple, Creator Hymn, Birth of Amun Re, cols. 22 and 23.

*nwi.n=f p.t t3 dw3.t*

“having **care**d for the heavens, earth and underworld.”<sup>9</sup>

OK. From Papyrus Berlin P 10474 AB recto, 92A–93A, line b3–6/7.

*šmi r ḥnw r jni.t ḥtp-ntr*

“Going to the **residence** to bring the sacrifice of god.”

OK. Pyramid Pepis I, PT 578§1534a.

*jn twt j š ḥ (w) i nni.w = šn m- ḥnw ʕ = k*

“Because it is you who prevents them from getting **tired/ weary** [resting] in your arms.”

OK. Pyramid Pepis II, PT 486§1040a-c.

*{i:} mi.w m nw, w n ḥpr.t p, t n ḥpr.t t3 n ḥpr.t*

“I (?) was born in the Nu / (water) before the sky came into existence before the earth came into being.”

c. 518 bc, Darius I. Hybis Temple, Great Amun Hymn of Karnak, cols. 40–42.

*ntk Nwn-wr; nni sw ḥr ʕh.t*

“You are **Nun** the Great, who **settles** upon the fields ...”

The idea of *nw* as restfulness is brought out in this pun from the Great Amun Hymn. Klotz points out “The verb *nni*, literally ‘to become inert’, has a secondary meaning, ‘to subside’ or ‘to settle’, when describing the inundation”<sup>10</sup> (i.e. ‘rest’).

## Summary

From the linguistic evidence discussed above, the following comparison can be made:









Hebrew Noah (‘console’, ‘home’, ‘rest’) ≈ Egyptian Nu (‘console’, ‘home’, ‘rest’) ≈ Ogdoad Nu (‘console’, ‘home’, ‘rest’).

Egyptian personal and divine names are phonetically equivalent to Hebrew Noah and form flood epithets. Vocabulary with *nu* roots share an equivalent semantic range in the OK with the meaning of Noah’s name, offering support for the hypothesis that these names were understood in the same way, and that Noah and his wife became deified ancestors as the Ogdoad couple Nu and Nu.t. (figure 1).

## Third test case: Japheth—an Egyptian-sounding name

The biblical name ‘Japheth’ is anglicized in its pronunciation—containing English consonants ‘j’ and ‘th’. From Hebrew *yāḇeṯ* to English, ‘j’ is substituted for ‘j’ and ‘th’ for /t/; such is the case for Egyptian consonants also. Regarding the initial vowel in ‘Japheth’, Loprieno’s comment is relevant: “the semiconsonantal, or semivocalic glides /j/ [pronounced ‘i’] and /w/, vowels, remain ... for the most part unexpressed”,<sup>11</sup> and “in later Egyptian were dropped.”<sup>12</sup> Loprieno comments regarding Egyptian labial “homorganic sounds” /p/ and /b/, that they were known to “coalesce” (i.e. /p/ > /b/ and vice-versa).<sup>13</sup> It has also been noted that the ‘interdental fricative’ phonemes *ḏ* and *t* likely merged from OK Egyptian into Late Egyptian /t/ and /d/.<sup>14</sup> With these phonetic considerations in mind, personal and divine names containing tri-consonantal phonetic roots *ipt/ibt/wpt/wbt* will be used as search terms. Table 4, below, presents the results of this search within Egyptian lexicons.

**Table 4.** Egyptian personal and divine names phonetically equivalent to Hebrew Japheth

RPN#	Personal Name	Hieroglyph	Date
I, 24.16	<i>ipt</i> (lpet)		NK
I, 21.20	<i>ib.t</i> (lbet)		?
I, 78.4	<i>wp.t</i> (Wepet)		OK (Giza)
I, 77.14	<i>wbḥ.t</i> (Webket)		NK
Wörterbuch#	Divine Name	Hieroglyph	Date
I, 68.7	<i>ip.t</i> (lpet)		NK (Karnak)
II, 359	<i>wp.t-wṣ.wt</i> ("which Opens the Ways")		OK (PT)
II, 360	<i>wp.t</i> ("The Opener")		MK
II, 360	<i>wpt-nt-mw</i> ("Divider of the Waters")		NK

### Discussion of results

From RPN, 6 *ipt*; 7 *ibt*; 6 *wpt*; 1 *wbt* personal names were found, LGG records 19 *ipt*; 1 *ibt*; 0 *wbt*; 41 *wpt* divine names; representative examples of which are shown in table 4. These names are phonetically equivalent to Hebrew Japheth, found from OK–NK periods, and also occur as a flood epithets. However, only 2 variants appear as divine names *ipt* and *wpt*.

### Japheth: meaning of the biblical name

יָפֶֿתֿ יִבְרָאֵֿהִם לְיִפְתָּֿהּ ...

"God shall enlarge (*yaḇt*) Japheth (*yéḇet*) ..." (Genesis 9:27).

The biblical meaning of 'Japheth' is derived from the text of Gen. 9:27. Noah drew upon the meaning of Japheth's name to formulate his personal blessing upon Japheth's discretion recorded in Gen 9:21–27. The Hebrew word 'יָפֶֿתֿ' (HALOT-3882) is clearly being drawn upon by Noah. In the qal 1 stem it means "to be simple"; in the niph'al and puel "to be deceived"; and piel "to entice". However, none of these aspects make sense in the context in which Japheth is blessed. Alternatively, 'יָפֶֿתֿ' in the qal 2 stem means "to be open" and in the hiphil it means "to make wide". An analysis of the verb reveals

it is hiphil imperfect and jussive in both form and meaning. Therefore, the idea of being made to be 'spacious' and 'wide-open' should be the accepted meaning (HALOT-7802). Jones makes some pertinent comments regarding the meaning of Japheth's name:








"The eldest son of Noah. He was called Japheth, that his name might answer to the promise of God ... 'God shall enlarge Japheth.' His posterity being both numerous and widely diffused, accords well with the etymology of his name; he was enlarged both in territory and in children. His posterity possessed ... those vast regions of the earth anciently inhabited by the Scythians, embracing the western and northern regions of the globe."<sup>15</sup>

Other researchers have noted the similarities of Japheth's name to that of the Greek god Iapetos,<sup>16</sup> or Jupiter,<sup>17</sup> which befits his descendants' northern migrations. Table 5 lists

**Table 5.** Hebrew lexical range for 'Japheth'

TWOT#	Translit.	Translation	Ref.	Text Example
1853a	<i>yaḇt</i>	"be spacious, wide"	Gen. 9:27	"God shall enlarge (יָפֶֿתֿ) Japheth ..."
1854a	<i>ḇēṭah</i>	"opening, doorway"	Gen. 6:16	"the door (פֶּֿתַח) of the ark shalt thou set in the side ..."
1854	<i>pāṭah</i>	"open"	Job 3:1	"After this Job opened (פָּֿתַח) his mouth ..."

**Table 6.** Egyptian vocabulary containing *wb/wp/pd* roots

Wörterbuch#	Egyptian	Translit.	Translation	Date
I, 298.7–301.12		<i>wb3, wpi</i>	"to divide; to open; to judge; open"	OK
I, 300.6		<i>wp.t-r'</i>	"Opening-of-the-mouth (ceremony)"	MK
I, 567.8–568.13		<i>pḏ</i>	"to stretch out; to spread out"	OK
I, 568.5; 2, 271.17		<i>pḏ</i>	"to stride widely"	OK
I, 78.4		<i>wp.t</i>	"Wepet (personal name)"	OK
I, 302.5		<i>wp.w</i>	"doors"	OK
I, 571.9		<i>pḏ.w</i>	"flood"	Ptol.

biblical vocabulary associated with Japheth's name representing its semantic range.

To test if biblical ‘Japheth’ shares a common semantic range with Egyptian names, *wb/wp/pd* roots are used as search terms. Table 6 records results of an interrogation of TLA.

## Discussion of results

*TLA* returned the following words: *ip*-34; *ib*-72; *wp*-38; *wb*-33. Table 6 lists all root words discovered that share meaning with ‘Japheth’. Tables 5 and 6 offer strong parallels between the semantic range of Japheth and Egyptian words containing similar phonetic roots. Egyptian *pḏ* is shared semantically with Hebrew *pōlēṯ*<sup>h</sup> with words meaning ‘wide’ and ‘spacious’. The OK personal name Wepet (*wp.t*) occurs as a divine name: “The Opener”, and a flood epithet *wp-n.t* “He who divides the flood”. Egyptian ‘*wp*’

is phonetically comparable to Hebrew ‘*ypt*’ with identical meanings ‘open, wide’ (and ‘flood’ association), offering convincing evidence ‘*wpt*’ was understood the same way as ‘Japheth’. Such data supports the hypothesis that Ham influenced Egyptian language and religion in terms of names and associated vocabulary (figure 2).

## Comparing 'Japheth' to the Ogdoad

The names of the Ogdoad are discussed in parts 1 and 2, one member in particular—Heh—has immediate semantic (but not phonetic) connections to Japheth in terms of concepts of ‘expansiveness’. Table 7 lists shared vocabulary when comparing phonetic roots for Heh.

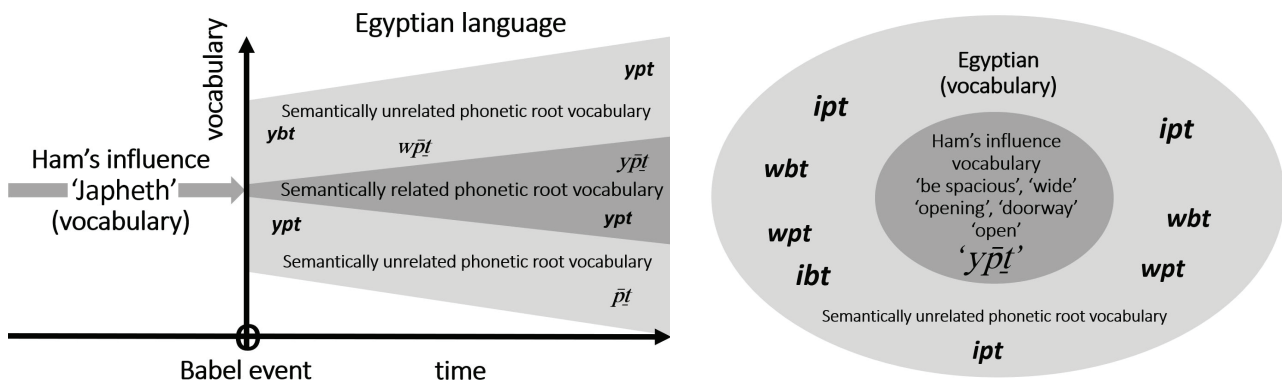
The semantic range of Japheth's name includes concepts of 'stretching out', 'wide', and 'open', which accords well with Heh, whose name shares phonetic roots with equivalent OK words: 'eternity', 'infinity', 'million', and 'search'. Heh is also a NK word describing the Egyptian flood. Furthermore, an OK word 'Heh' means 'tribe, or clan' referring to people groups, consistent with Japheth's posterity (*Gentiles-gôyîm*) spreading far and wide.

Representative text examples possessing roots ipt, pd

Listed below are four Egyptian texts containing words with phonetic roots *ipt*, *pḏ*. The examples chosen represent key vocabulary associated with the meaning of Japheth's name, and the Ogdoad member—Heh.

OK. Unas Pyramid, PT 54, line 52.

(w)sjr (| wnjs |) **wpi** r<sup>c</sup> = k m mḥ.t im = k  
 “Osiris Unas, **Open** your mouth with it.”



**Figure 2.** Influence of Ham on Egyptian vocabulary



Table 7. Relevant semantic range of Heh

Wörterbuch#	Egyptian	Translit.	Translation	Date
III, 152.14–153.24		hh	"eternity, infinity, million"	OK
III, 152.14–153.24		hjhj, hh	"to seek, to look, to search"	OK
I, 254.8–12		hh, hjhj	"Heh, Hehi" (personal, divine names)	OK
III, 152.9–10		hh	"flood"	NK
(AL 77.2826)		hh	"tribe, or clan"	OK

Table 8. šm/sm/śem personal and divine names

RPN#	Personal Name	Hieroglyph	Date
I, 327.19	šm3		OK
I, 327.20	šm3i		OK
1, 296.18	smj.tj		MK
1, 296.17	smj.t-k3		MK
1, 307.1	śm		MK
1, 307.7	śmn		OK
Wörterbuch#	Divine Name	Hieroglyph	Date
IV, 486.16–19	šms.w-hr.w (Follower of Horus)		OK
IV, 467.8–10	śm.ti		MK
LGG VI, 306.	sm (Sem)		OK
IV, 121.13	śm		OK (Palermo stone)
IV, 142.12–16	šms.w (Semsu, "oldest one")		MK

OK. Pyramid of Neith, PT 71J, line 328.

pd pf aha pn

"That one is stretched out, this one stands."

OK. Pyramid of Teti, PT 406, line 340.

... gw3 = k m- hnt hh.y = f

"... if you land in front of his Heh (sky-support) gods."

OK. Pyramid Pepis I., PT 1007, line 95.

wḏ = k mdw n hh hwi n = k hfn. sdb

"Thou shalt grant millions of orders, hundreds of thousands [for you] to ward off evil."

NK. KV 9: Tomb of Ramses VI, Celestial Cow, line 6.

b3 pw n hhw hw.t

"The ba [spirit] of Heh is the flood."  
(Note the pun with 'Heh' hhw and 'flood' hw.t.)

#### Summary

From the linguistic evidence discussed, the following comparison can be made:

Hebrew Japheth (open, wide)

≈ Egyptian wb/wp/pḏ (open, wide) ≈ Egyptian Heh (infinity, million, flood).

Egyptian personal and divine names phonetically equivalent to Hebrew Japheth carry equivalent meaning and support the hypothesis these names correspond to biblical Japheth. These names occur as divine names and flood epithets, and can successfully be compared to Heh and Heh.t, a divine pair from the Ogdoad.

#### Fourth test case: Shem—an Egyptian-sounding name

Loprieno discusses three relevant sibilants: "the Old Kingdom Egyptian displays three phonemes, usually transcribed z (or s), s (or ś), and š".<sup>18</sup> Loprieno states both Hamo-Semitic š and ś are continued by Egyptian s (ś). Egyptian š survives as Coptic *ϣ*. Furthermore, monoconsonantal /m/,<sup>10</sup> survived into Coptic as nasal, labial *ⲙ*.<sup>19</sup> With these phonetic considerations,

equivalent-sounding personal and divine names can be searched for by phonetic root: *šm*, *sm*, *śm*. Table 8, below, presents the results of this search within Egyptian lexicons.

#### Discussion of results

From RPN 33 *šm*, 32 *sm*, 12 *śm* personal names are listed, LGG records over 300 *sm*, 223 *śm*, 11 *śm* divine name variants. The personal and divine names in table 8, possessing sibilants *š*, *s*, and *ś*, are representative examples, occurring in OK texts, but persist into the NK, demonstrating all three

sibilant name variations existed. These names, as far as can be determined, sound identical to biblical Shem.

Shem: meaning of the biblical name

וַיִּשְׁמַר כְּרִידֵי יְהוָה אֱלֹהֵי שֵׁם

“Blessed be the LORD, The God of Shem (šēm) ...”  
(Genesis 9:26).

The meaning of Shem can be discerned contextually at Genesis 9:24–27 within Noah’s blessing formula for Shem’s discretion. Ross states: “Yahweh makes himself a name in becoming the God of Shem, and thus entwines His name with that of Shem, which means ‘the name’.”<sup>20</sup> Theologically,

Shem is fulfilling priestly functions in being so closely identified with YHWH.<sup>21</sup> Jones comment is noteworthy:

“Shem ... son of Noah. He is placed before his brethren, probably because God conferred on him the honour of being a progenitor of the blessed Messiah; and because he was the great opposer of idolatry. God therefore distinguished him among his brethren, and he became peculiarly His, as Noah emphatically declares ...”<sup>22</sup>

The semantic range for Shem is given by the standard Hebrew lexicons: šēm “name, brand, mark, reputation, representative, glory”<sup>23</sup>; “name, name of a god, renown, fame”<sup>24</sup>; “name, celebrated and distinguished”.<sup>21</sup> Table 9

offers examples of how ‘šēm’ appears in context, representing a theoretical semantic range.

To test if Hebrew and Egyptian ‘Shem’ share a common semantic range, šm, sm, śm roots are used as search terms. Table 10 records results of an interrogation of *TLA*.

#### Discussion of results

*TLA* was searched for words containing phonetic roots šm, sm, śm, which yields: šm-141; sm-284; śm-85 words. Table 10 offers examples of vocabulary shared between the semantic range for Hebrew Shem and Egyptian vocabulary containing šm, sm, śm phonetic roots, which supports the hypothesis of the influence of Ham (figure 3). (However, some key corresponding vocabulary occurs only in later texts, not displayed here). A common OK noun *rn* means ‘name’, but only by the MK do semantically equivalent phonetic words occur: *sm* and *śm* meaning ‘title’, and *śmnḥ* ‘perpetuating a name’. ‘Image’ and ‘statue’ occur by MK *śmnḥ* and NK *śśm.w*. (Images or statues represent people, or gods—in the same way names represent people to which they belong). The concept of Shem as priest may be reflected in the OK term ‘sem’ “priest”. The semantic links with these three phonetic roots is weak in the OK, compared to evidence presented for Noah, Ham, and Japheth. It cannot be stated with certainty that Shem ‘sound-alike’ names, in the OK, were understood in the same way as biblical Shem.

**Table 9.** Semantic range associated with the name ‘Shem’

Ref.	Translit.	Translation	Ref.	Text Example
TWOT-2405	shēm	“name”	Gen. 2:11	“The <b>name</b> (שם) of the first is Pishon.”
TWOT-2405	shēm	“name”	Gen. 4:26	“Then men began to call on the <b>name</b> (שם) of the LORD.”
BDB-10046	shēm	“reputation, character, brand, mark, glory”	Gen. 6:4	“... mighty men which were of old, men of <b>renown</b> (שם).”
Holl-8694	shēm	“posthumous renown, memory, standing”	Gen. 11:4	“... let us make us a <b>name</b> (שם) ...”

**Table 10.** Egyptian vocabulary containing roots šm, sm, śm

Wörterbuch#	Egyptian	Translit.	Translation	Date
IV, 470.1		šm3	“noun in a title”	MK
IV, 290.14–291.5		sšm	“manifestation (of a god); nature (of a god)”	NK
V, 119.3–9		śm	“Sem-priest”	OK
IV, 136.7–137.25		śmnḥ	“make distinguished; make effective; embellish; endow”	OK
(Lesko, 41)		smī	“reputation”	NK
III, 451		sm3	“title, name”	MK
IV, 137.24–25		śmnḥ	“keep your name in good memory (to perpetuate a name)”	MK

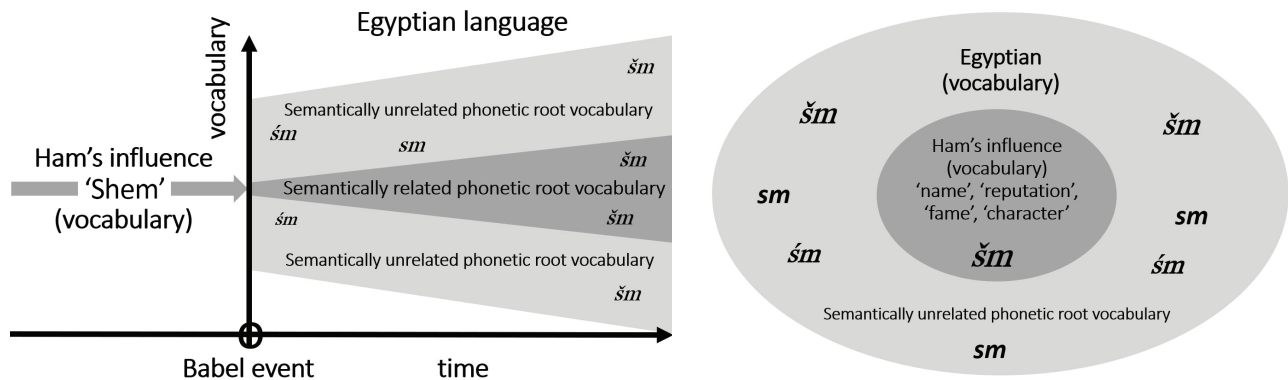


Figure 3. Influence of Ham on Egyptian language (vocabulary)

Biblical Shem corresponds to the Ogdoad

‘Shem’ is encapsulated in the concept ‘name’. As was discussed in parts 1 and 2, “Hidden of Name” (*jmn-rn*, Wb 1, 84.1) is an OK title. Ogdoad member Amun possesses this identical phonetic root (*jmn*). Table 11 compares words that share the semantic range of Shem with bi-consonantal phonetic root vocabulary shared by Ogdoad member ‘Amun’—*mn*.

Table 11 lists, by phonetic root, words that share the lexical field with biblical Shem, offering the possibility the name Amun could have been understood in a similar way to Shem—particularly in the sharing of nouns for ‘identity’. Interestingly, an OK word containing the *mn* root (*mndf.ti*)

means “Author of the Flood”, which occurs in the Pyramid Texts (Pepis I, PT 486).

Representative text examples with root *šm*, *sm*, *šm* in context

Listed below are four Egyptian texts containing words possessing phonetic roots *šm*, *sm*, *šm*. The examples chosen represent key vocabulary associated with the meaning of Shem and the Ogdoad member—Amun.

[MK. Tomb of Chnumhotep II \(Beni Hasan 3\), Biography Chnumhoteps II, lines 41.](#)

*smn.n = f n = j wd šma smnh wd = sn mi pt*

“... he **established** the southern stele for me, he made the northern stelae **excellent** like heaven ...”

[NK. Papyrus Cairo CG 24095 \(pMaiherperi\), Tb 127, line 559.](#)

*dw3 ntr. šsm, w. dw3.t jn dd = f*

“The gods and **images** of the underworld worship ... he says ...”

[OK. Unas Pyramid, PT 301, line 558.](#)

*jmn hna jmn.t m hnm, tj ntr. šnm ntr. m š {j} w = sn*

“**Amun** and **Amaunet**, (you) both ... the gods, who unite the gods with their shadow.”

[NK. Papyrus Anastasi \(Pap. Brit. Mus. 10247\), Line 12, 6.](#)

*wn-f nk 3s hr p3i-i smi*

“... that he may quickly disclose to thee my **reputation**.”<sup>25</sup>

Summary

From the linguistic evidence, the following comparisons are made:

Table 11. Comparing *mn* root words with the lexical field for Shem

Wb#	Egyptian	Translit.	Translation	Date
II, 64.13–65.2		<i>mn, mn.t</i>	“so and so – someone; the like; who?”	OK
I, 84.1		<i>jmn-rn</i>	“Amun/ hidden name”	OK
II, 66.1–3; I, 83.7–11		<i>mn, imn.yt</i>	“daily offerings, lasting sacrifice”	OK
II, 89.5		<i>mnš</i>	“Cartouche (name ring); to brand (with the king’s cartouche)”	NK
II, 86.15–17		<i>mnḥ.w</i>	“excellence; virtues”	OK
IV, 136.7–137.25		<i>šmnḥ</i>	“to make distinguished; to make effective; to embellish; to endow”	OK
IV, 137.24–25		<i>šmnḥ</i>	“keep your name in good memory, (to perpetuate a name)”	MK
II, 92.9		<i>mndf.ti</i>	“Author of the Flood”	OK



Hebrew Shem (name, reputation ...)  $\approx$  Egyptian *sm*, *šm*,  
*śm* (name, reputation ...)  $\approx$  Amun *mn* (likeness, image).

Egyptian personal and divine names are phonetically equivalent to Hebrew Shem. However, within OK, equivalent meaning is difficult to establish—in the MK onwards, a stronger case is made. In OK, the meaning of Shem is successfully compared to Ogdoad couple Amun and Amun.t.

### Conclusion

Parts 3 and 4 demonstrate Noah, Ham, Shem, and Japheth were known as phonetically equivalent Ancient Egyptian personal and divine names, likely through Ham's influence. Part 3 considered how biblical names were understood in context, and how phonetically similar words were played upon to derive name meanings. It is asked, can a similar case be made with phonetically equivalent Egyptian names? Do these names carry equivalent semantic ranges, when compared to their Hebrew counterparts? Were these 'sound-alike' names understood the same way? These articles have sought to confirm this, demonstrating the evidence is most relevant in the OK, where from a biblical-historical perspective, the cultural and linguistic influence is strongest.

In summary, the Hebrew Flood patriarchal names, when compared with Egyptian phonetic counterparts, share equivalent meanings. This occurs in the oldest examples, so the case is made they were understood the same way. When compared to the Ogdoad names, there are striking semantic similarities. Noah and sons' names can be compared with Egyptian 'sound-alike' personal/ divine names and Ogdoad names thus:

Noah  $\approx nw \approx Nw$   
 Ham  $\approx hm/hm/hm/km \approx Kek$   
 Japheth  $\approx ipt/wpt \approx Heh$   
 Shem  $\approx sm/sm/sm \approx Amun$

The evidence presented cannot be claimed as 'proof' these names were understood the same way—because ancient Egyptians, long gone, cannot be personally consulted—but it supports the hypothesis. The evidence suggests the names of the Flood patriarchs influenced Egyptian onomastics and associated vocabulary, via Ham's influence, in fundamental ways. This can be discerned in equivalent phonetic Egyptian names, which share semantic connections with their Hebrew counterparts. Such evidence supports the hypothesis that Ham influenced Egyptian onomastics and religion—specific to this study, the semantic ranges of Noah and sons' names (figures 1–3). This sharing of semantics is observed when comparing Noah and sons' names with the Ogdoad names, thereby strengthening the hypothesis set up by this series, that the Ogdoad represent a polytheistic memory of Noah's family.

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# The use of single chromosome sequences as input for the Whole Genome K-mer Signature algorithm in molecular baraminology studies

Matthew Cserhati

The Whole Genome K-mer Signature (WGKS) algorithm was run on human, Neandertal, Denisovan, two chimp species, gorilla, mouse, and rat individual chromosomes to see whether analyzing a single chromosome is enough to compensate for the WGKS of a given species. In other words, can the information in a single chromosome be extrapolated to the entire genome to save computational time when running the algorithm and provide accurate results? The results show that there is a significant correlation ( $> 0.7$ ) between the k-mer signature of individual chromosomes and the whole genome. Comparing every combination of the k-mer signature of each human and murid chromosome showed without exception that these are enough to produce accurate baraminology classification between the human and the murid baramin. Thus, it appears that individual chromosomes can be used as a substitute for the whole genome sequence when running the WGKS algorithm.

A recently developed baraminology algorithm called the Whole Genome K-mer Signature (WGKS) algorithm has been tested on several insect genera, based on the analysis of the whole genome sequence (WGS) of these organisms.<sup>1,2</sup> A k-mer is a short oligonucleotide which is k bp long (around 6–20 bp). A k-mer can act as the core segment of a transcription factor binding site, repeat element, or other regulatory elements in the DNA.

The WGKS algorithm was devised to classify similar species into the same created kind, represented by a common genome, called a baranome. A baranome is a pluripotent, undifferentiated genome, with an intrinsic ability for rapid adaptation and speciation. The genomes of species today are derived from baranomes which have undergone sequential differentiation via mutations.<sup>3</sup> According to Terborg: “The best tool for baranome identification currently available, however, may be indicator genes. Indicator genes are essential genes with a highly specific marker.”<sup>3</sup> The author then mentions the genes *FOXP2* and *HAR1F* as indicator genes specific to the human baranome. Statistically significant k-mers could be used as diagnostic genetic elements to determine the baraminic membership of a given species, similar to the indicator genes of baranomes.

A lot of computational time would be saved if a smaller, representative portion of the genome (i.e. an individual chromosome) could be analyzed by the WGKS algorithm instead of the whole genome sequence. Thus, instead of defining the WGKS for the genome of an organism, a Chromosome K-mer Signature (CKS) would suffice if it can be shown to be representative enough of the WGS. This would allow the WGKS to be run more efficiently, since a lot less input data would have to be processed.

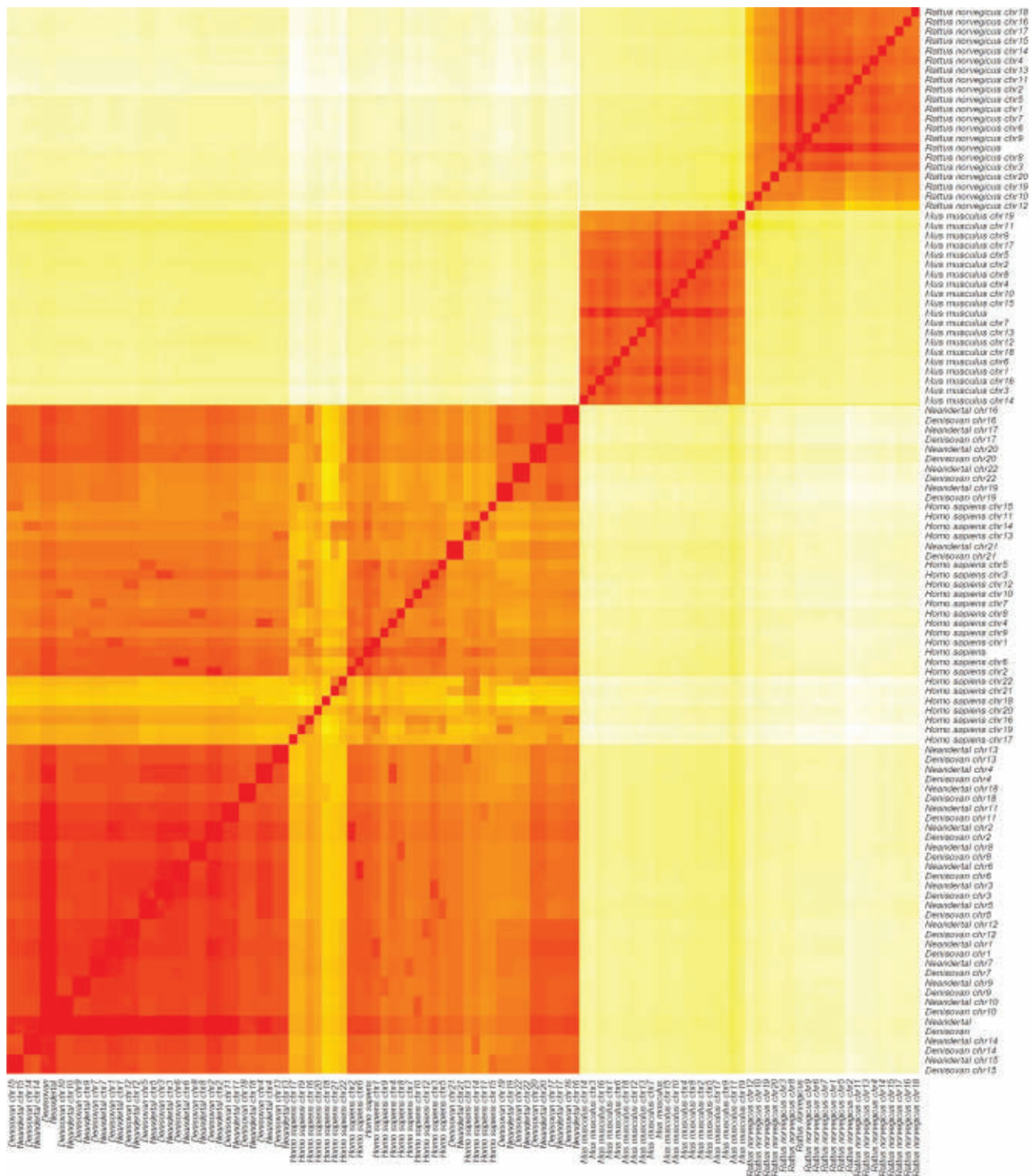
Therefore, the goal of this study was to run the WGKS algorithm on all human, Neandertal, Denisovan, mouse, and rat autosomal chromosome sequences and compare their CKS to that of their respective genome as well as to one another. Chromosomes 2 of the three humans and the two murids were compared with chromosomes 2A and 2B of the two chimps and of gorilla. Sex chromosomes were not analyzed due to their difference to autosomes. In this way, three different baranomes could be compared with one another, i.e. those of human, simians, and of the murid kinds. If the k-mer signature of individual chromosomes were similar enough to that of the WGS, this meant that single chromosomes could be substituted for the WGS when running the WGKS algorithm.

## Results and discussion

The latest versions of the whole genome sequence of these organisms were downloaded and separated into their constituent chromosome sequences. The WGKS was then determined for each autosomal chromosome of humans and murids as well as for the whole genome. Next, two sets of comparisons were made. First, the WGKS of each species was compared to each of the Chromosomal K-mer Signatures (CKS). The second set of comparisons involved comparing each CKS with one another within the same species. During each comparison, the Pearson Correlation Coefficient (PCC) was used to measure the similarity between the two k-mer signatures. The PCC values were then displayed in a heat map (see Materials and Methods).

### Clustering results

Figure 1 depicts the PCC values for the human and murid genomes and their chromosomes. The Hopkins clustering



**Figure 1.** Graphical representation of correlation values in a heat map between the Whole Genome K-mer Signatures and the Chromosome K-mer Signatures of human, Neandertal, Denisovan, mouse, and rat the Chromosome K-mer Signatures. Lighter colours indicate correlation values between k-mer signature pairs closer to 1, whereas darker values represent lower correlation values.

statistic is 0.965, indicating that the data is of excellent quality for clustering. There is a perfect separation between the three human genomes and the two murid genomes, which represent two distinct baramins, respectively.<sup>4</sup> This same

result has also been shown by the Gene Content Method (GCM), a molecular baraminology method that classifies two species into the same created kind if they have a large proportion of overlapping genes.<sup>5</sup> Within the human baramin,



**Table 1.** Minimum, mean, median, and maximum correlation values with standard deviation for two sets of k-mer signatures for human (hg38), Neandertal, Denisovan, mouse (mm10), and rat (rn6). For each species, the Whole Genome K-mer Signature was compared to the Chromosome K-mer Signature of all chromosomes (top row). Another comparison was done amongst the Chromosome K-mer Signatures of the individual chromosomes (bottom row). The correlation values coming from both comparisons were compared via a t-test, together which provide a p-value.

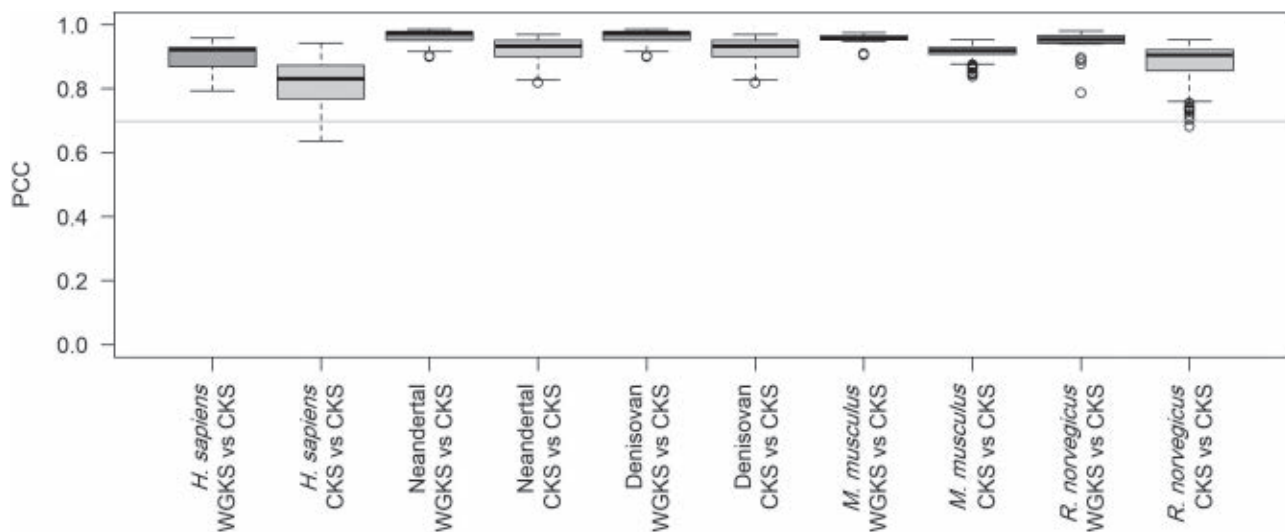
Comparison	Minimum	Mean	Median	Maximum	St. dev.	p-value
hg38 vs chromosomes	0.794	0.901	0.922	0.958	0.045	1.42E-8
hg38 chromosomes	0.637	0.820	0.831	0.944	0.064	
Neandertal vs chromosomes	0.900	0.961	0.972	0.987	0.026	5.80E-7
Neandertal chromosomes	0.819	0.924	0.933	0.970	0.034	
Denisovan vs chromosomes	0.900	0.962	0.972	0.987	0.026	6.09E-7
Denisovan chromosomes	0.819	0.924	0.934	0.970	0.034	
mm10 vs chromosomes	0.905	0.955	0.959	0.976	0.018	3.17E-9
mm10 chromosomes	0.838	0.914	0.919	0.953	0.022	
rn6 vs chromosomes	0.787	0.940	0.954	0.981	0.046	3.63E-5
rn6 chromosomes	0.682	0.885	0.905	0.952	0.055	

the individual chromosomes of Neandertal and Denisovan intermingle with one another, in pairs. This also reveals how highly similar the three human genomes are.

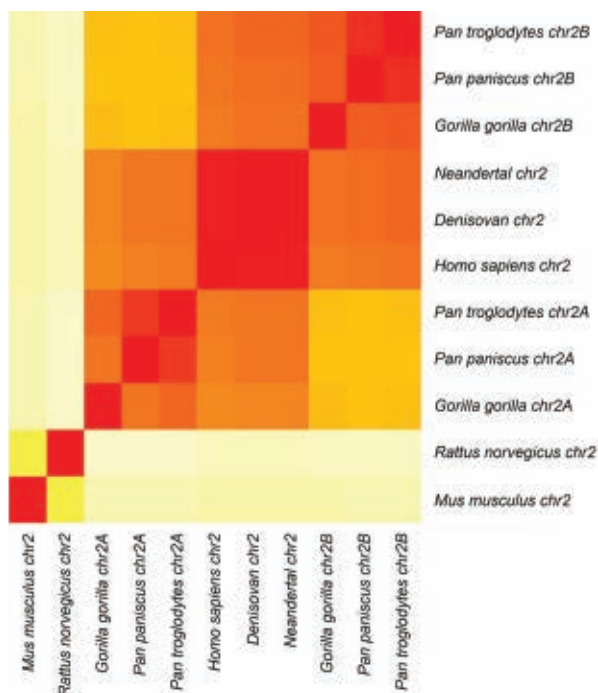
Figure 2 shows a boxplot of PCC values from comparisons between the WGKS and the CKS of human, Neandertal, Denisovan, mouse, and rat chromosomes. The mean PCC value  $\pm$  std. dev. is provided in table 1. Figure 2 is a graphic representation of the data in table 1. Each inter-species PCC value between the WGS and individual autosomal chromosomes

is above 0.7 (horizontal line in figure 2), indicating a strong correlation between the WGKS and the CKS.

The picture changes when PCC values between individual CKS within a given species are compared. Table 1 shows that some of the inter-chromosomal PCC values are below 0.7, as in human and rat. These two species have a minimum PCC value of 0.637 and 0.682, respectively. Although these PCC values may seem low, this is less important than comparing the CKS to the WGKS, since the main goal of the WGKS



**Figure 2.** Boxplots of correlation values from comparisons between the WGKS and CKS of the individual chromosomes within the same species (dark grey), compared to correlation values coming from the comparison of individual CKS with one another within the same species (light horizontal line drawn at PCC = 0.7.).



**Figure 3.** Graphical representation of correlation values in a heat map between the Whole Genome K-mer Signatures of chromosome 2/2A/2B for human, Neandertal, Denisovan, *P. troglodytes*, *P. paniscus*, *G. gorilla*, mouse, and rat decamers. Lighter colours indicate correlation values between k-mer signature pairs closer to 1, whereas darker values represent lower correlation values.

algorithm is to capture genetic information which is representative of the WGS.

In order to test whether it truly is possible to use a single chromosome to compare CKS between species, PCC values from a comparison of the CKS between each of the 22 human, 22 Neandertal, 22 Denisovan, 19 mouse, and 20 rat chromosomes were extracted from the PCC matrix to form 4,046,240 (22 x 22 x 22 x 19 x 20) individual 5-by-5 PCC mini-matrixes. These species were used because they belong to two well-known baramins. Then the k-means clustering algorithm was run on each of these mini-matrixes to see what kind of clustering resulted. This corresponded to 4,046,240 different clustering results. Every single combination of CKS consistently clustered the three human genomes together, and separately from the two murids, with a 100% accuracy rate.

#### Exclusion of chromosomal bias

The results suggest there is a high correlation between the CKS of individual chromosomes and the WGKS. Are these high correlations real or the by-product of comparing individual chromosomes with the WGS? This could be a possible outcome since the WGS consists of all the chromosomes and as well contains the same information as an individual chromosome does. The redundant information in the genome compared to a single chromosome sequence might skew the

CKS. In other words, since the genome sequence consists of all chromosomes, would an individual chromosome falsify the PCC value when comparing its CKS with the WGKS? How does the CKS of a given chromosome relate to the genetic information in the rest of the genome?

To this end, a ‘quasi-WGKS’ was calculated for human chromosomes 1–5. For each chromosome its sequence was deleted from hg38, and the WGKS algorithm was run on the resultant truncated version of hg38. Then these five quasi-WGKS were compared to the CKS of each of the five corresponding chromosomes, specifically to that chromosome missing from the truncated WGS. This represents five comparisons and five PCC values.

The values in column 2 of table 2 represent the PCC values between the CKS of chromosomes 1–5 of hg38 and the hg38 genome. Column 3 of table 2 represents the PCC value between the CKS of chromosomes 1–5 of hg38 and the WGKS of the truncated hg38 WGS. Column 4 shows the difference in the PCC values between the WGKS of untruncated hg38 and the CKS of chromosomes 1–5, and the PCC values between the WGKS of the truncated hg38 and the five CKS. There is only a very slight average difference in the PCC values shown in column 4 of table 2 (7.8E-3). A two-tailed t-test of unequal variance was run on both sets of PCC values (from columns 2 and 3 in table 2), giving a p-value of 0.387, which is statistically insignificant (> 5%). This means that the PCC value between the WGKS and the CKS of a given chromosome is accurate, even though the WGS contains the sequence of the given chromosome. It also means that an individual chromosome can be used as a substitute for the WGS when running the WGKS algorithm. Furthermore, a PCC value can also be used to unite or separate two separate species into the same or different baramins, although this cut-off depends on each study.

#### Analysis of chromosome 2/2A/2B

The WGKS of chromosome 2 of modern human, Denisovan, Neandertal, mouse, and rat as well as chromosomes 2A and 2B of *Pan troglodytes*, *Pan paniscus* and *Gorilla gorilla* were determined for k=10 (decamers). The resulting PCC matrix was visualized in figure 3. The Hopkins clustering statistic is 0.765, which means that the data is of suitable quality for clustering.

Here modern humans and simians both separate well from the two murids at a statistically significant level ( $p < 1\%$ ). However, modern humans mixed in with simians, even though chromosome 2 of humans separated from chromosomes 2A and 2B individually. As opposed to this, modern and archaic humans separated from simians when comparing common orthologous protein content.<sup>5</sup> This means that in some cases, species from different baramins may be similar to one another on a global, genomic level, but separate from each other on a chromosomal level.

## Conclusion

In this article, the main question was whether the sequence of a single chromosome could adequately represent the whole genome sequence as input to the WGKS algorithm. To this end, the algorithm was run on the individual chromosomes besides the whole genome for five species from two different baramins, and chromosome 2A and 2B for three simian species. The Pearson correlation values between the k-mer signature of the individual chromosomes (the CKS) and the WGKS were all high ( $> 0.7$ ). A general trend can be seen in that the larger the chromosome, the closer the PCC value is to 1.0. Therefore, if any one chromosome can be chosen, larger ones are preferred. Furthermore, baramins may be separated from one another based on the CKS of an individual chromosome, as in the case of chromosome 2/2A/2B in humans and simians.

A separate analysis showed that the correlation between the WGKS and the CKS is not skewed since the WGS contains the same information as each individual chromosome. All possible combinations of CKS were compared between humans and murids, showing that the CKS can be used to separate species into baramins. In conclusion, it appears that individual chromosome sequences can be used as input to the WGKS, thereby allowing much computational time to be saved during analysis. Further analyses are needed, but hopefully running the WGKS algorithm on single chromosomes will be an effective and efficient tool for molecular baraminology analyses.

## Materials and methods

The hg38 human, mm10 mouse, and rn6 rat genome sequences were downloaded from the UCSC Genome Browser website, whereas the *P. paniscus*, *P. troglodytes*, and *G. gorilla* genomes were downloaded from the NCBI website at the addresses found in Supplementary File 1 at [github.com/csmaty/wgks\\_optimization](https://github.com/csmaty/wgks_optimization). The Neandertal and Denisovan WGS were downloaded from [golgi.unmc.edu/HumanMotifomeData](https://golgi.unmc.edu/HumanMotifomeData).<sup>6</sup> The WGKS script was downloaded from github at: [github.com/csmaty/motif\\_analysis/blob/master/motif\\_analysis\\_k-1.py](https://github.com/csmaty/motif_analysis/blob/master/motif_analysis_k-1.py).

Python 3.0 was used to calculate the WGKS of the genome and chromosome sequences. Version 3.6.0. of R was used to depict the correlation values on a heat map using the 'heat map' command. The 'boxplot' command was used to depict

**Table 2.** Correlation values for comparing the Chromosome K-mer Signature of human chromosomes 1 to 5, compared to the Whole Genome K-mer Signature of hg38 (column 2) and its truncated version. For each chromosome, the given chromosome sequence was deleted from hg38, see column 3. The difference in the correlation value between the two comparisons can be seen in column 4.

chromosome no. (hg38)	PCC with hg38	PCC with truncated hg38	Difference between complete hg38 and truncated hg38
1	0.958	0.951	0.007
2	0.95	0.943	0.007
3	0.934	0.925	0.009
4	0.926	0.918	0.008
5	0.937	0.93	0.007

**Table 3.** PCC value statistics for humans, simian chromosome 2A, simian chromosome 2B, and murids

Baramin	Species	min	mean	max	stdev	p-value
Humans	3	0.977	0.984	0.999	0.012	6.93E-7
Simian chr. 2A	3	0.756	0.808	0.883	0.067	2.94E-3
Simian chr. 2B	3	0.808	0.848	0.917	0.061	8.31E-4
Murids	2	0.249	0.249	0.249	NA	9.29E-19

correlation values. The 't.test' command was used in R to calculate p-values between different sets of PCC values for the five species.

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# Rapid growth of caves and speleothems: part 2—growth rate variables

Michael J. Oard

Although growth rates depend on many variables, there are five main ones that determine the rate of carbonate growth of speleothems. First, the most significant variable is the concentration of calcium ions in the drip water and the resulting supersaturation that occurs when the drip water enters the cave. This depends upon the amount of soil carbon dioxide that is dissolved into the soil water. As the soil water percolates through the carbonate, carbonic acid slowly dissolves the rock. Second, cave temperature has a major effect, and depends largely upon the surface air temperature. Third, cave air ventilation is also an important factor. Better ventilation increases the growth rate of a speleothem. Fourth, rapid speleothem growth generally requires a higher drip rate. Fifth, the thickness of the water film on top of the stalagmite (which is increased by a higher drip rate) is another major variable. In addition to these five generally recognized variables, evaporation is a significant variable at Carlsbad Caverns, which is well ventilated. It could have been a significant variable for other caves, as well.

## The variables needed for speleothem growth

Many variables and complex processes determine the growth or dissolution of speleothems.<sup>1,2</sup> Research has been conducted on stalagmites because stalactites, being located on the cave roof, are difficult to study (for obvious reasons). The main variables for the growth of a stalagmite are: (1) concentration of the drip water  $\text{Ca}^{2+}$  ion; (2) cave temperature; (3) cave atmospheric partial pressure of  $\text{CO}_2$ ; (4) drip water flow rate; and (5) the thickness of the thin film of water flowing over stalagmites (table 1).<sup>3,4</sup> In addition to these five variables, another will be briefly discussed and that is evaporation, which for most caves is now insignificant, but could have been significant during the Ice Age. All of these variables depend upon many other variables, which makes the use of stalagmites as records of paleoclimate difficult. However, this is a major reason why so much research and literature exist on cave speleothems.<sup>5-9</sup>

Researchers also measure many trace elements, such as Mg and Sr, and isotope ratios, such as  $\delta^{18}\text{O}$  and  $\delta^{13}\text{C}$ , within the stalagmites. They believe these trace elements give them more information about the conditions for carbonate deposition.<sup>10</sup> Nonetheless, there are many other variables involved<sup>11</sup> that can cause misinterpretation. Impurities within the drip water can inhibit calcite deposition,<sup>46</sup> such as Mg, which can be common in carbonate that contains a fair proportion of dolostone. Moreover, aragonite commonly forms instead of calcite in carbonates that have a higher proportion of dolostone,<sup>12</sup> and aragonite, since it is metastable, can transform into calcite with time.

Isotope ratios are thought to be related to the paleoclimate, such as glacial/interglacial oscillations in the uniformitarian ice age paradigm. However, both  $\delta^{13}\text{C}$  and  $\delta^{18}\text{O}$  in

speleothems can result from many variables, which makes paleoclimate interpretations difficult.<sup>13</sup> Cheng *et al.* write:

“Although the speleothem  $\delta^{18}\text{O}$  signatures can be influenced by numerous and complex factors . . . . However, the climate interpretation of  $\delta^{18}\text{O}$  records remains a subject of considerable debate, particularly in the EASM [East Asian summer monsoon] domain.”<sup>14</sup>

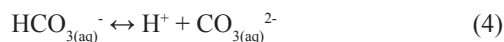
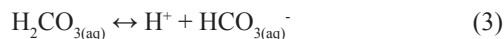
I will discuss the five main variables, and some of their related variables. We need to understand how speleothems grow in order to show in part 3<sup>15</sup> that the very slow calcite deposition rates today would have been greatly accelerated during the post-Flood Ice Age.

## The drip $\text{Ca}^{2+}$ ion

Of the variables above, the concentration of the  $\text{Ca}^{2+}$  ion in the drip water is the most important for calcite deposition on speleothems.<sup>16</sup> This depends primarily upon the partial pressure of the soil  $\text{CO}_2$  and any changes in the water that percolates through the top of the carbonate before entering the cave (figure 1). The partial pressure of soil  $\text{CO}_2$  in turn depends upon more variables.<sup>17</sup> The carbonate layer just below the soil is generally called the epikarst and is typically 15 to 30 m (50 to 100 ft) thick. The rest of the carbonate above the cave is called the vadose zone in which air fills the cracks and voids. It is the zone above the water table, which includes the epikarst. The phreatic zone is the zone below the water table, which is normally below cave level.

The following are the basic equations in the conversion of atmospheric  $\text{CO}_2$  to carbonic acid in the soil or epikarst:<sup>18</sup>





where the “(g)” means the gaseous state and “(aq)” means dissolved in the water. Equation (1) is the rate limiting process that slows down the other conversions in equations (2) to (4), which proceed rapidly to equilibrium.<sup>19</sup> Equation (3) represents the dominant end process with equation (4) a minor variant. Only a small proportion of the  $\text{CO}_2$  is converted to carbonic acid.<sup>20</sup> Much  $\text{CO}_{2(\text{g})}$  escapes the soil into the air, which interestingly is 10 times the emission of  $\text{CO}_2$  to the air as from fossil fuels.<sup>21</sup> Moreover, all these reactions are reversible and go in the direction from the high-concentration species to the low-concentration species until equilibrium is reached. In other words, if the groundwater is high in  $\text{CO}_{2(\text{aq})}$ , the reaction will go towards  $\text{H}_2\text{CO}_{3(\text{aq})}$  and finally to  $\text{H}^+ + \text{HCO}_{3(\text{aq})}^-$ . So, the groundwater becomes mildly acidic forming carbonic acid when  $\text{CO}_2$  is added to the groundwater.

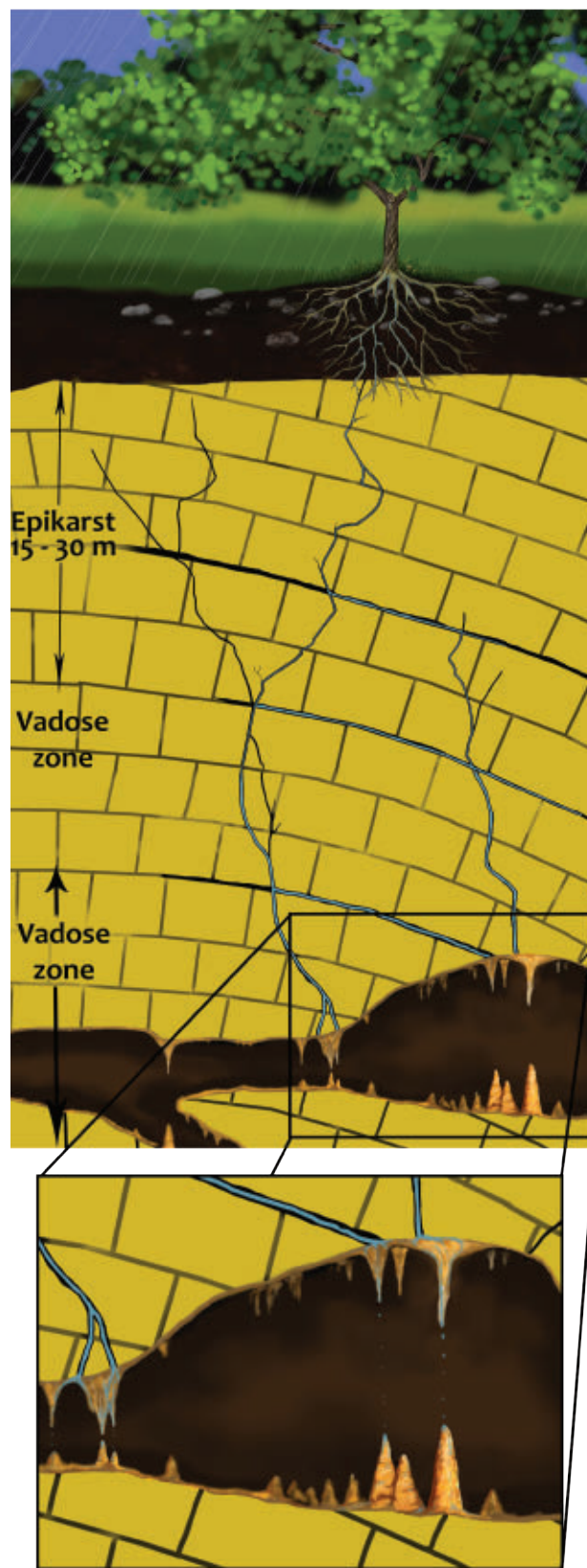
When this water begins to seep down through the cracks in the epikarst, it dissolves the calcite ( $\text{CaCO}_3$ ) and gives off  $\text{CO}_2$  to the water or air in the vadose zone. The downward-seeping water quickly becomes saturated with  $\text{Ca}_{(\text{aq})}^{2+}$ .

When the water enters the cave chamber with lower partial pressure of  $\text{CO}_2$  than the drip water,  $\text{CO}_2$  escapes from the water according to the following reaction:



The drip water is generally neutral upon entering the cave, but quickly becomes supersaturated upon the degassing of  $\text{CO}_2$  (figure 2). Nonetheless, this reaction is also reversible, as equation 5 shows. When a lot of calcium and carbonic acid is in the drip water, the reaction goes to the right and speleothems grow, proportional to the concentration of  $\text{Ca}^{2+}$ . But, if there is little  $\text{Ca}^{2+}$  in the water (undersaturated), the reaction goes to the left, dissolving calcite on the speleothems. In carbonate caves, the reaction almost always goes to the right. As such, it is the degree of  $\text{Ca}^{2+}$  supersaturation upon  $\text{CO}_2$  degassing that determines the growth of speleothems.

However, the excavation of the cave opening would require undersaturation, if it were really dissolved by carbonic acid (which it was not<sup>22</sup>), while deposition requires supersaturation. As more  $\text{CO}_2$  is liberated into the cave air, the drip water becomes progressively more supersaturated. Thus, the greater the supersaturation, the faster the speleothem growth. Still, deposition of calcite does not automatically happen when supersaturation first occurs. It must first reach a threshold of about 10% before calcium carbonate can be deposited on speleothems.<sup>23</sup> However, if other elements such as Mg are present,  $\text{CaCO}_3$  deposition will be inhibited. In equation (5), the evaporation of  $\text{CO}_2$  from the drip water is the rate-limiting step and slows the reaction going toward the right. All the other reactions are much faster.



**Figure 1.** Drawing of soil and vegetation, epikarst, vadose zone, cave with speleothems forming from drip water (by Melanie Richard)

**Table 1.** The five main variables that determine stalagmite growth

1) Concentration of the drip water $\text{Ca}^{2+}$ ion
2) Cave temperature
3) Partial pressure of $\text{CO}_2$ in the cave atmosphere
4) Drip water flow rate
5) The thickness of the water film on the stalagmite

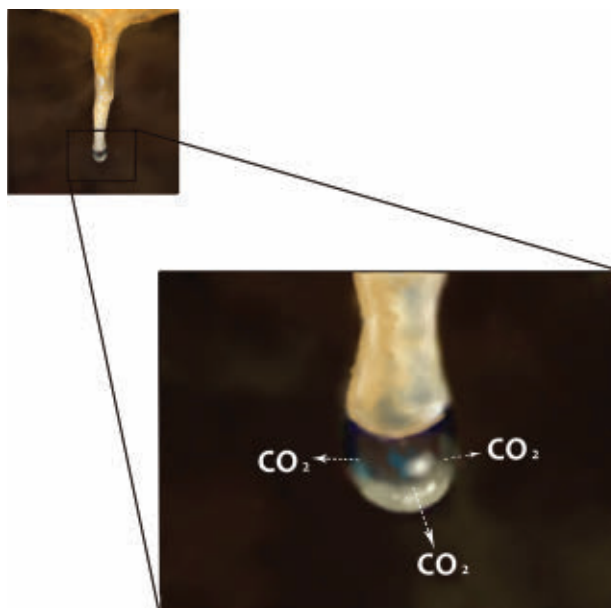
**Table 2.** Five main soil respiration processes

1) Root respiration
2) Rhizomicrobial respiration
3) Decomposition of plant residues
4) Root exudation and plant residues
5) Microbial oxidation of SOM

### The importance of the soil carbon dioxide

The drip water calcium ion concentration in the cave depends upon the amount of carbonic acid formed in reactions (1) to (4) in the soil. Then, as the carbonic acid seeps down through cracks in the carbonate, calcium is dissolved by reaction (5) going to the left. The amount of calcium liberated to the seeping water depends upon the amount of soil  $\text{CO}_{2(\text{aq})}$ —the *main variable* that controls the growth of speleothems.

Soil water carbon dioxide is a product of soil respiration when oxygen in the soil is converted to gaseous carbon dioxide and then to soil water carbon dioxide by reaction (1). Much is still unknown about soil respiration.<sup>24,25</sup> There are five types of soil respiration: (1) root respiration; (2) rhizomicrobial respiration; (3) decomposition of plant residues; (4) the priming effect induced by root exudation or by addition of plant residues; and (5) the basal respiration by microbial decomposition of soil organic matter (SOM) (table 2).<sup>26</sup> Two minor abiotic sources for soil  $\text{CO}_{2(\text{aq})}$  are dissolution of carbonate in the soil and chemical oxidation,<sup>27</sup> which will be ignored. The first four mechanisms are related to the existence of trees and plants, whose soil effects can last several years, and is called autotrophic respiration. The fifth is called heterotrophic respiration. It also depends upon the time of day, the season, the root type, the root size, and the nitrogen content.<sup>28</sup> If all vegetation dies out, heterotrophic respiration would continue as long as there is SOM, which can last for centuries before being used up.<sup>29</sup> SOM respiration depends upon the quality and quantity of SOM.<sup>27</sup> Considering all of the above caveats, estimating the soil  $\text{CO}_{2(\text{aq})}$  is difficult.

**Figure 2.** Drop at end of a stalactite degassing  $\text{CO}_2$  (by Melanie Richard)

In general, researchers assume that autotrophic respiration accounts for 50% of soil carbon dioxide and heterotrophic respiration 50%. However, the proportion of soil carbon dioxide from autotrophic and heterotrophic respiration varies considerably over the earth, with autotrophic respiration ranging from 10% to 90%.<sup>27</sup> To determine the amount of autotrophic respiration, Hogberg *et al.* girdled (killed) trees and measured the change in soil respiration, which decreased 54% in 1 to 2 months.<sup>30</sup>

Soil respiration rates depend strongly on many environmental variables: air and soil temperature, soil moisture, evaporation from the soil, seasonality, soil depth, vegetation type and density, type of vegetation cover, and oxygen concentration in the soil air.<sup>4,6,16,31</sup> However, the vegetation type apparently does not matter much.<sup>32</sup>

Soil temperature is the most important factor controlling soil respiration rates. Some researchers believe soil respiration increases *exponentially* with a rise in temperature.<sup>27</sup> However, the situation is much more complicated.<sup>33</sup> The exponential increase with rising temperature is probably a short-term result since the SOM decreases, and therefore the effect of a temperature increase in the long term is small.<sup>34</sup> Nonetheless, the importance of soil temperature is reflected in the fact that forested tropical soils have the highest soil carbon dioxide.<sup>35</sup> Still, other factors contribute, such as that they are thicker, warmer, and form soil carbon dioxide *all year around*, while at mid and high latitudes soil carbon dioxide decreases in winter because of cooler temperatures and/or frozen ground. This is also the reason why caves in tropical climates have great speleothem growth. The water content of the soil is probably the second most important



variable. If it is too dry, soil respiration decreases substantially, but if it is too wet, oxygen cannot be transferred fast enough for soil respiration.<sup>20</sup> So, an intermediate amount of soil moisture is ideal.

The importance of vegetation was shown when the area above a mine in Wiltshire, England, was revegetated with a deciduous forest; the calcite deposition rate on a mine stalagmite increased fourfold.<sup>36</sup> Under ideal conditions, the partial pressure of soil  $\text{CO}_{2(\text{aq})}$  can reach an incredible 100,000 ppm or  $1/10^{\text{th}}$  of an atmosphere.<sup>6,37</sup> However, measured  $\text{CO}_2$  rarely reaches 100,000 ppm. The total amount of soil carbon dioxide theoretically could reach 210,000 ppm<sup>38</sup> if all the soil oxygen were somehow all used up, but this is likely impossible. These figures compare with an atmospheric  $\text{CO}_2$  partial pressure of 400 ppm. Regardless, soil  $\text{CO}_{2(\text{aq})}$  is usually about 100 times that of the atmosphere. High soil  $\text{CO}_{2(\text{aq})}$  results in high  $\text{Ca}_{(\text{aq})}^{2+}$  and  $\text{HCO}_{3(\text{aq})}^-$  in the cave drip water, which will result in a rapid growth of cave speleothems.

### Flow from soil to cave

Once the water leaves the soil and descends downward through the vadose zone, the carbonic acid dissolves the carbonate according to reaction (5). Dissolution normally occurs within the top 10 m (33 ft) of the epikarst, where the solution equilibrates and no more calcium carbonate is dissolved.<sup>39</sup>

The amount of  $\text{Ca}^{2+}$  entering the water will depend not only upon the amount of carbonic acid in the water, but also whether the vadose zone is a closed or open system. A closed system is one in which the percolating water that seeps down into the vadose zone has little air in the interstices compared to the amount of water.<sup>40</sup> An open system is one in which there is abundant air in the vadose zone. In an open system that can have a high amount of  $\text{CO}_2$  in the air (see below), the amount of  $\text{CO}_2$  absorbed and carbonic acid formed is significantly greater than in a closed system.<sup>41,42</sup> In reality, vadose zone water percolation is usually neither totally closed nor totally open, but somewhere in between.<sup>40</sup>

Besides the air in vadose zone joints and faults, water can obtain a little more carbonic acid from roots that can sometimes go deep into the epikarst, which also helps with the water flow.<sup>43,44</sup> Moreover, organic matter can wash down into the karst to provide more air carbon dioxide for the water.<sup>45</sup> In fact, some researchers believe that the main source of the carbon in speleothems comes from SOM washed down into the vadose zone.<sup>9</sup> Drilling on the Rock of Gibraltar discovered that many caves and voids were penetrated with high carbon dioxide content.<sup>45</sup>

As water flows from the soil down into the cave, it can also deposit calcite in air pockets, joints, faults, and cave ceilings, which is called prior calcite precipitation (PCP).<sup>46</sup> This can only happen if these air-filled voids are low in  $\text{CO}_2$ ,

which normally does not occur. Of course, as the water issues from a crack in the ceiling of a cave, it will start depositing calcite on the roof before it reaches the tip of a stalactite. Since researchers are mostly focused on stalagmites, calcite deposition on the stalactite is also usually included in PCP.<sup>47</sup> It is also known that the faster the discharge, the less the PCP, and vice versa. So heavy precipitation would favour faster stalagmite growth with less PCP.<sup>46</sup>

### Temperature

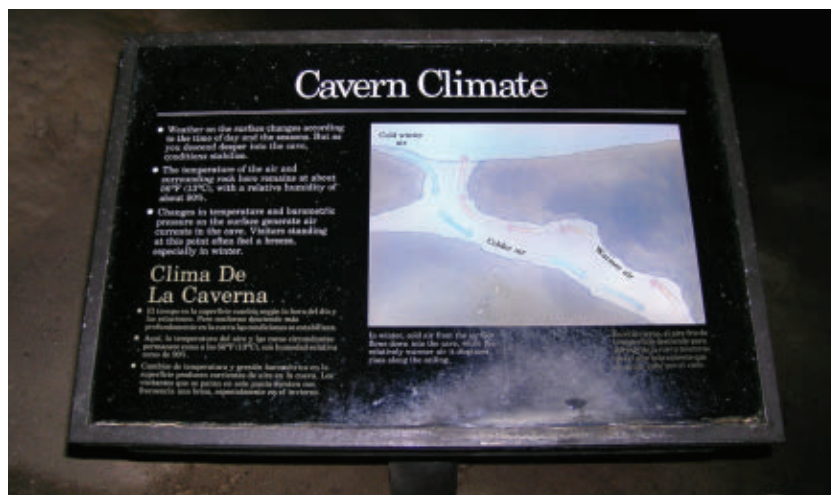
Temperature is a significant variable. The warmer the cave temperature, the faster the deposition of  $\text{CaCO}_3$ , especially if winters are mild. Many caves at mid and high latitudes show a significant decrease in the generation of soil  $\text{CO}_{2(\text{aq})}$  and speleothem growth. The decrease in soil  $\text{CO}_{2(\text{aq})}$  in winter would be averaged with the summer increase, and such seasonal effects would diminish the average  $\text{Ca}_{(\text{aq})}^{2+}$  and  $\text{HCO}_{3(\text{aq})}^-$  in the drip water, and hence slow speleothem growth rate. This however may not have an immediate effect. The drip water moves downward through the limestone at quite variable rates and mixes with water that may be a few years old. Alternatively, the drip water can reach the cave in a matter of days, weeks, or months, depending upon the particular path it takes through the vadose zone.

Areas that became glaciated during the Ice Age would have produced little growth in speleothems during the time of ice coverage. There are a few exceptions, e.g. speleothems can form under glaciers and karst with no soil or vegetation.<sup>48,49</sup> Several mechanisms have been suggested for this anomaly.

Since cave temperatures are generally similar to the average surface air temperature, cold winter temperatures will reduce the deposition rate of  $\text{CaCO}_3$  in the cave during winter. However, in some locations increasing winter ventilation (discussed next) due to storminess could actually cause an increase of  $\text{CaCO}_3$  deposition, despite cooler winter temperatures. This is the case in central Texas caves where winters are mild and ventilation more than makes up for the cooler temperatures.<sup>50</sup>

### Cave atmospheric partial pressure of $\text{CO}_2$

As the drip water exits the carbonate rock above the cave,  $\text{CO}_{2(\text{aq})}$  leaves the water in the form of a gas,  $\text{CO}_{2(\text{g})}$ .<sup>17</sup> The speed of degassing  $\text{CO}_2$  depends upon the amount of  $\text{CO}_2$  within the cave atmosphere. The larger the difference between liquid and gaseous carbon dioxide, the faster  $\text{CO}_2$  in the water degasses and carbonate is added to the speleothem. As long as  $\text{CO}_{2(\text{aq})}$  is greater than  $\text{CO}_{2(\text{g})}$  within the cave, calcite deposition will occur. But, as  $\text{CO}_2$  is added to the cave atmosphere during the above process, the rate of degassing



**Figure 3.** Illustration of convection circulation from Carlsbad Caverns

will decrease.  $\text{CO}_2$  can also be added to a cave if a stream runs through the cave.<sup>17</sup> For every molecule of  $\text{CO}_2$  expelled from the water, one molecule of  $\text{CaCO}_3$  is deposited either on the cave wall or on speleothems.<sup>51</sup> All reactions within the water proceed rapidly except the change of  $\text{CO}_{2(\text{aq})}$  to  $\text{CO}_{2(\text{g})}$ , which becomes the rate limiting reaction.<sup>51</sup> Therefore, speleothems will grow faster with lower partial pressure of  $\text{CO}_2$  in the cave.<sup>52,53</sup>

Cave air  $\text{CO}_2$  today can be quite high and variable, generally from about 800 ppm to over 8,000 ppm,<sup>17</sup> which was added to the cave from  $\text{CO}_{2(\text{aq})}$  changing to  $\text{CO}_{2(\text{g})}$ . Central Texas caves were measured to have a carbon dioxide content as high as 37,000 ppm.<sup>54</sup> Therefore, the growth of speleothems will strongly depend upon how well the cave is ventilated (removing excess  $\text{CO}_2$  gas); the morphology of the cave passages; the size, number, and location of entrances; and the distance from an entrance. All these variables depend especially on the climate.

Cave air is ventilated especially by the surface wind that causes a sucking action. Pressure and temperature differences between the cave and the outside air also will cause air exchange. Even moisture differences can drive a circulation.<sup>52,53</sup> As a result, cave ventilation is subject to forcing by diurnal, seasonal, and weather pattern variations. As such, ventilation of most caves is relatively fast.<sup>55</sup> Mid- and high-latitude caves commonly have lower cave air carbon dioxide in winter than in summer.<sup>52</sup> This is due to increased storminess, wind, and cooler air temperatures than the interior of the cave. Low cave air  $\text{CO}_2$  levels in winter is one reason why some stalagmites in Texas caves grow faster during the winters than summers.<sup>54</sup> Cave  $\text{CO}_2$  also depends upon the location within the cave, with passageways farther from the exits having more cave air  $\text{CO}_2$ .<sup>4</sup> When the entrance is higher than the cave, air convection in the winter causes cold air to sink into the cave and warm air to exit above the entering

cold air (figure 3).<sup>56</sup> It probably does not take much cave air exchange to keep the cave air  $\text{CO}_2$  relatively low, as winters in Texas, which are not all that stormy, demonstrate.

### Drip water flow rate

It is well known that percolating water from above follows different paths for different stalagmites—there is fast flow through cracks that arrives quickly after precipitation, and there is diffuse flow that may take a year or more. The characteristics of the drip also depend on the thickness of the carbonate above the cave; the porosity

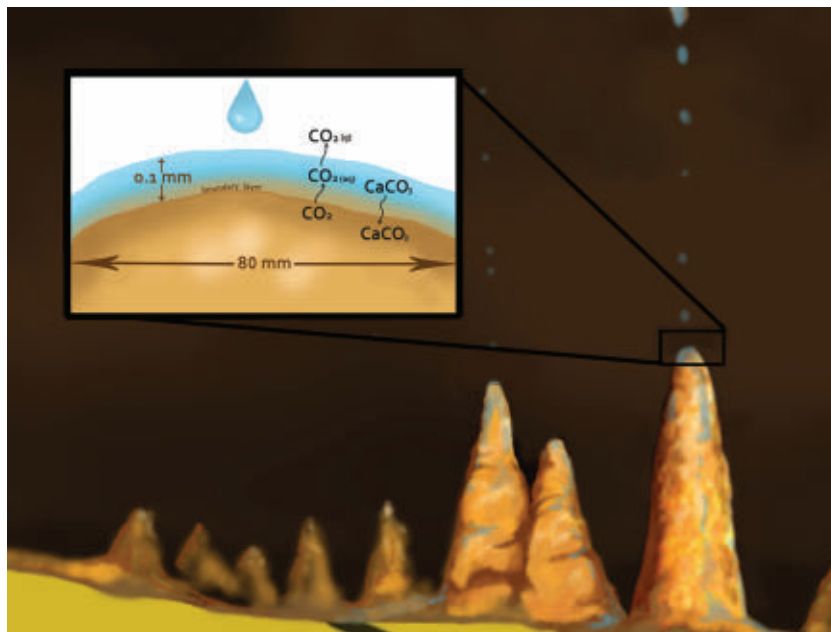
and permeability of the vadose zone carbonate; the purity of the bedrock; and the particular path of the groundwater, which can vary with time.<sup>4,16</sup> So, each speleothem in each cave is unique with a unique drip rate. Moreover, the flow path can change, which is one reason why the drip rate can vary significantly at any one stalagmite. In general, however, the higher the drip rate, the faster a speleothem will grow,<sup>7,57</sup> although some researchers do not find a relationship.<sup>58</sup>

Cave water drip rate is also non-linearly related to effective precipitation. Effective precipitation is the precipitation minus any soil drying.<sup>3,6,36</sup> So, the greater the precipitation and the less the soil evaporation, the greater the drip rate.<sup>7</sup> Faster drip rates increase stalagmite radius.<sup>59</sup> The growth rate is also related to drop volume, which depends on several variables, such as the radius, surface curvature, and geometry of the stalactite tip.<sup>60</sup> Many studies of growth rates use conservative drip volumes.

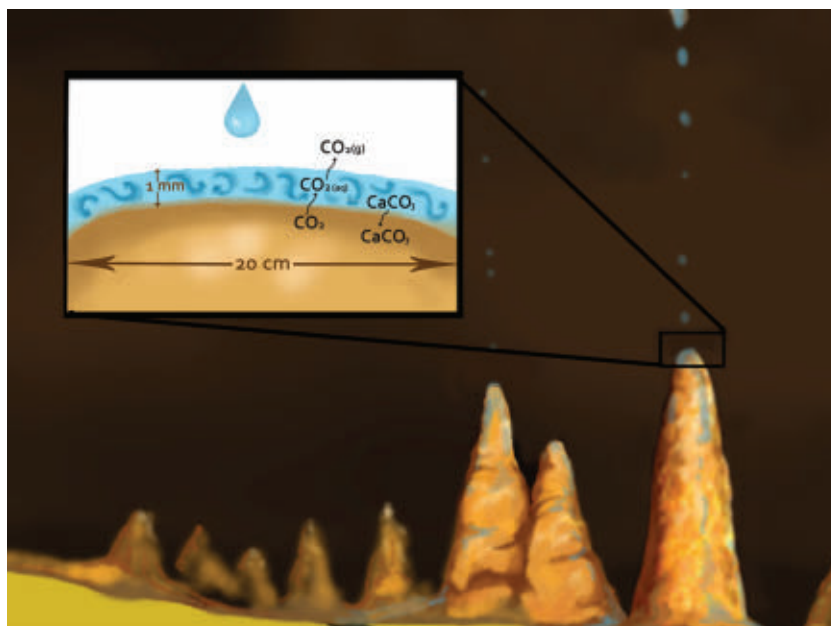
### Thickness of the water film on the stalagmite

The last variable, water film thickness on the stalagmite, is difficult to evaluate. But, the thicker the film, the faster  $\text{CaCO}_3$  deposition occurs on the stalagmite, which also depends upon the morphology of the apex, and deposition decreases linearly with increasing apex curvature.<sup>61</sup> If the apex is nearly flat, the film thickness can be about 1 mm or more, resulting in high growth rate.<sup>61</sup> The higher the drop fall, the thinner the film due to splashing, another important variable. However, high drop fall and splash also degasses  $\text{CO}_2$  faster, which causes more drip water calcium supersaturation that can aid growth.

Film thickness is often assumed to be only 0.1 mm since stalagmites are usually convex up.<sup>31</sup> But the deposition rate is not as fast as often assumed because of a kinetic effect, which is complicated. In the thin film of water that is either



**Figure 4.** Schematic of the kinetic effect showing diffusion through a thin film of 0.1 mm on top of a convex upward stalagmite of 80 mm in diameter (by Melanie Richard). Carbonate deposition is slow in this situation because the boundary layer is relatively thick and diffusion slow.



**Figure 5.** Schematic of the kinetic effect showing deposition in turbulent flow in a film of 1 mm thick on a less-curved stalagmite of 20 cm in diameter (by Melanie Richard). Carbonate deposition is fast in this situation because the boundary layer is thin and diffusion length through the boundary layer is low.

stagnant or moving in laminar flow on top of the stalagmite, there is a very thin boundary layer next to the calcite (figure 4). At the surface of the carbonate, one molecule of calcium carbonate is added, while one molecule of  $\text{CO}_2$  is liberated,<sup>51</sup> which causes concentration gradients within the thin film. The deposition rate depends upon the diffusion of  $\text{Ca}^{2+}$  and

$\text{HCO}_3^-$  from the layer above through the boundary layer to the surface of the stalagmite. At the same time,  $\text{CO}_{2(aq)}$  must diffuse from the carbonate surface upward into the layer above, where it degasses. It is degassing of  $\text{CO}_2$  at the top of the water film that is rate limiting and keeps the process rather slow.<sup>4,62</sup> Concentration gradients build up in the thin film that must be relieved by diffusion, a slow process.

The growth will of course depend upon the thickness of the boundary layer. A thick boundary layer will result in slower diffusion. But in turbulent flow, generally considered when the film thickness is 1 mm or greater, the boundary layer is much thinner, so that diffusion length is much less between the thin boundary layer and the thick film above, and so mixing between the layers occurs much faster (figure 5). In this case, deposition is about 10 times as fast.<sup>5,63</sup> Moreover, the thicker the film, the more the ions are available above the boundary layer to diffuse downward into the boundary layer. However, turbulent flow is not expected on the top of a stalagmite, at least between drops, but it could occur briefly during splashing of the next drop. Turbulent flow normally occurs when the water is flowing down a slope. This is why flowstone can form much faster than carbonate deposition on stalactites and stalagmites.

### Evaporation

There is a sixth variable that could contribute to growth in the evaporation of water from the speleothem but rarely applies in caves today. As equation (5) shows, water loss means that  $\text{CaCO}_3$  must be deposited. Evaporation is usually ignored since the relative humidity

in most caves today is near 100% due to evaporation and underground streams.

However, if ventilation is significant with even a little wind in the cave, and even a slightly lower relative humidity, speleothems can grow.<sup>64</sup> At a relative humidity of 88%, 10 times the evaporation occurs than at a relative humidity



of 99%.<sup>65</sup> The relatively low relative humidity, as well as low CO<sub>2</sub>, applies to Carlsbad Caverns, which does have good ventilation. However, this is mostly because very little water is dripping into the cave with few speleothems actually growing. Practically all speleothems in Carlsbad Caverns are considered relic, formed in some past climate that is not occurring today.<sup>65</sup> For those speleothems that are growing, 40% of the growth rate is attributed to evaporation. Evaporation also strongly affects the oxygen and carbon isotope ratios and the paleoclimate inferences.<sup>66</sup>

Regardless, if ventilation is strong enough in the past, the reduced relative humidity could be another significant variable for speleothem growth.<sup>67</sup>

### Summary

We have analyzed the five main variables that determine speleothem growth. It is the calcium ion concentration in the drip water that is the most important variable, which strongly depends upon the amount of soil carbon dioxide percolated downward through the vadose zone. This is where the carbonic acid from the soil quickly dissolves some of the CaCO<sub>3</sub> until equilibrium, a point reached where it is no longer an acid. But additional changes in the ion concentrations in the drip can occur on the way down to the cave. When the high partial pressure of carbon dioxide enters the cave in the drip water, it is rapidly degassed, inversely proportional to the partial pressure of the carbon dioxide in the cave. In general, speleothem growth is proportional to the temperature of the cave, the amount of drip water falling from the ceiling, and the thickness of the water film. Evaporation can also cause speleothem growth if cave ventilation is significant, such as observed at Carlsbad Caverns. All the relationships between these variables are usually too much to track effectively, so researchers often rely on empirical relationships between major variables, such as the Ca ion concentration and/or the supersaturation, to measure the relative impact of different factors on speleothem growth rates.

In part 3, we will show that these variables, plus variables from the Flood, would maximize speleothem growth in the Ice Age, especially early in the Ice Age.

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# Rapid growth of caves and speleothems: part 3—Flood and Ice Age variables

Michael J. Oard

Present-day growth rates of speleothems are around 0.1 to 2 mm/yr, but can vary from zero to more than 5 mm/yr. The variables summarized in part 2 would have been near maximized in the early-to-mid post-Flood Ice Age, producing tremendously rapid speleothem growth. They would then have decreased considerably by the end of the Ice Age. Two variables related to the end of the Flood will be discussed that would further aid the early rapid growth of speleothems. Growth could easily be over a hundred times that of today in some caves.

Uniformitarian scientists have long considered caves to be a challenge to the short timescale of Scripture. However, uniformitarians are not without their own challenges, as summarized in part 1.<sup>1</sup> For instance, it has recently been discovered that speleothems are much younger than they expected. Speleothems, once believed to take millions of years to grow, have been dated to be only tens of thousands to hundreds of thousands of years old by their own dating methods. Moreover, instead of taking millions of years to dissolve out a cave by carbonic acid dissolution, secular scientists have discovered strong evidence that increasingly points toward sulfuric acid having excavated most of the cave openings. Sulfuric acid is much stronger than carbonic acid and would rapidly excavate a cave, especially when combined with the uplifting of the continents relative to the ocean basins at the end of the Flood. Uplift would cause joints and faults to form, enabling acidic water to drain downward, widening joints, faults, and weak bedding planes.

In part 2,<sup>2</sup> the variables that determine the growth of speleothems were discussed. Growth is a complicated process that mainly depends upon five major and many minor variables. These processes, coupled with the unique climate of the post-Flood rapid Ice Age,<sup>3,4</sup> open up many plausible avenues for interpreting the speleothems as forming rapidly after the Flood.

Before we can consider the possibilities for speleothem growth in the early-to-mid Ice Age, we need to know the present growth rates. In part 3, I will first point out what some secular researchers believe are average growth rates along with some noteworthy above-average growth rates. Then I will estimate the effects on the variables developed in part 2 that were potentially caused by the aftermath of the Flood and post-Flood Ice Age.

## Present-day growth rates

According to the literature, present-day speleothem growth rates are quite variable. This is as expected, since

there are many complicated variables that contribute to the growth rate.<sup>2</sup> Because only a few stalagmites have annual layers or a known beginning date (i.e. a date known when a stalagmite began growing on an object placed there), researchers commonly use radiometric dating methods to determine the growth rate. The most used method, touted as very accurate, is the U-series (uranium-thorium) method. Carbon-14 is sometimes used, but since water sinks from the soil to the cave, it dissolves the carbonate, which has very little carbon-14. So, soil water carbon is mixed with what is considered the 'dead carbon'. To determine the dead carbon fraction, researchers use other methods, such as  $\delta^{13}\text{C}$ , but this ratio depends upon many variables, such as the ratio of  $\text{C}_3$  to  $\text{C}_4$  vegetation on the surface, since  $\text{C}_3$  and  $\text{C}_4$  vegetation have very different  $\delta^{13}\text{C}$  measures.<sup>5,6</sup> As a result,  $\delta^{13}\text{C}$  cannot be trusted to accurately determine the dead carbon fraction.

In searching the literature for growth rates, estimated growth rates that depend upon radiometric methods were avoided, since they always seem to greatly exaggerate the time. Instead, only observed growth rates were used.

Baker *et al.* determined the growth rates of various stalagmites from three caves in southern England, France, and Belgium.<sup>7</sup> These areas generally experience precipitation throughout the year, but with high soil evaporation in the warm season. Some stalagmite drip rates dropped to zero, while others dripped year-around, mostly with variable rates. In Brown's Folly Mine in southern England (figure 1), growth rates ranged from 0.04 to 0.16 mm/yr. This range is likely in this mine because some drips stopped while others dripped throughout the year. At Grotte de Villars, France (figure 2), growth rates were  $0.55 \pm 0.35$  mm/yr, and at Godarville tunnel, growth rates were  $0.89 \pm 0.38$  mm/yr. Growth rates were generally proportional to the drip  $\text{Ca}^{2+}$  concentration. One stalagmite in one of the many caves in the Rock of Gibraltar (figure 3) grew at 0.9 mm/yr.<sup>8</sup> Since vegetation and soil on top of a cave often determines the growth rate, there does not

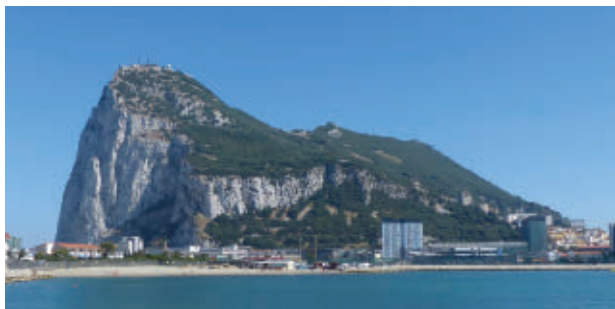
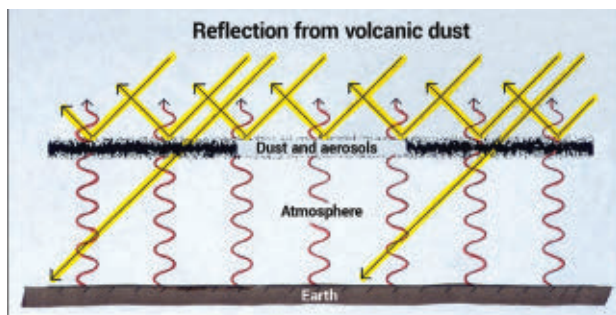




Image: Derek Hawkins/CC-BY-SA-2.0

**Figure 1.** Brown's Folly Mine, south-west England

Image: M.J. Galais/CC-BY-SA-3.0

**Figure 2.** Ancient drawing in the Grotto de Villars cave in south-west France**Figure 3.** West face of the Rock of Gibraltar, a limestone block with numerous caves, that is 426 m (1,398 ft) high**Figure 4.** Schematic of some of the solar radiation reflected from volcanic ash and aerosols in the stratosphere

seem enough vegetation and soil on the Rock of Gibraltar for this growth rate. Perhaps the warmer temperatures helped. Villars Cave, south-west France, has cool summers and mild winters and some stalagmites that grow 1.0 to 1.75 mm/yr.<sup>9</sup> Based on annual layers, some cave stalagmites in Belgium grew up to 2.17 mm/yr, with one year at 4.3 mm/yr.<sup>10</sup>

Hill and Forti have concluded that the average growth rate is one or two mm/yr:

“How fast do speleothems grow? We cannot predict a rate for a particular speleothem, but, on the average calcite travertine [on the speleothem] grows about a millimeter or two a year.”<sup>11</sup>

However, Dreybrodt gives smaller figures, claiming that growth rates are generally several hundredths to several tenths of a mm/yr, with a maximum observed about 5 mm/yr.<sup>12</sup> One growth ring in a stalactite from the Altai Mountains of southern Siberia grew at 15 mm/yr, which is 50 times faster than any other ring in the stalactite.<sup>13</sup> No other information was given; it appears that such a rate represents very unusual circumstances. Nonetheless, this shows growth rates can be many mm/yr, even in today's climate, if the specific conditions are favourable.

Referencing Carol Hill and Paolo Forti,<sup>14</sup> Musgrove *et al.* published that growth rates ranged from 0.002 to 400 mm/yr.<sup>15</sup> Of course, the real minimum is zero, which is the case for most speleothems in Carlsbad Caverns and the many other caves of the Guadalupe Mountains.<sup>16</sup> Intrigued by the observation of 400 mm/yr, I checked the reference in Hill and Forti, which was from a book by Trevor Shaw: “In one instance (Southall, 1878:93) a growth rate of over 30.3 cm per year was said to have been measured and in others the rate exceeded 5 mm/yr.”<sup>17</sup> Shaw listed 25 growth rates with an average of 3.7 mm/yr. It seems that Hill and Forti misquoted the growth rates from their source. Reading the interesting book by Southall, which challenged the so-called antiquity of man that was believed in the late 1800s, I discovered Southall did record observations of several rapid stalagmite growth rates, such as 7.3 mm/yr in a cave in Yorkshire, England.<sup>18</sup> It was reported that in a cave that mined lead (Pb) near Dubuque Iowa, stalactites grew about one metre in three years, which would be about 30 cm/yr,<sup>19</sup> as referenced by others.

However, most speleothems today are believed to be growing at the rate of less than a few mm/yr,<sup>20</sup> more like the estimates of Dreybrodt. Numerous articles indicate that the growth rates seem to generally lie between 0.1 and 2 mm/yr, similar to what Silvestru used to calculate the time for various speleothem growths.<sup>1</sup> Given this higher rate, speleothems do not need millions of years to form, which is why uniformitarian scientists now generally claim they form in tens to hundreds of thousands of years.

## The Ice Age climate

Much data in the literature is consistent with a rapid excavation of caves (see part 1) and rapid deposition of speleothems, if we dismiss the uniformitarian assumption of the ‘present being the key to the past’ and use a global Flood and rapid post-Flood Ice Age to explain the data. To see how this works, we must understand the Ice Age climate.

The Ice Age was a result of cooler summers caused by Flood and post-Flood aerosol particles trapped in the stratosphere and a warm ocean.<sup>3,4,21,22</sup> After briefly describing the Ice Age, I will focus on key features of the Flood and Ice Age that result in rapid speleothem growth.

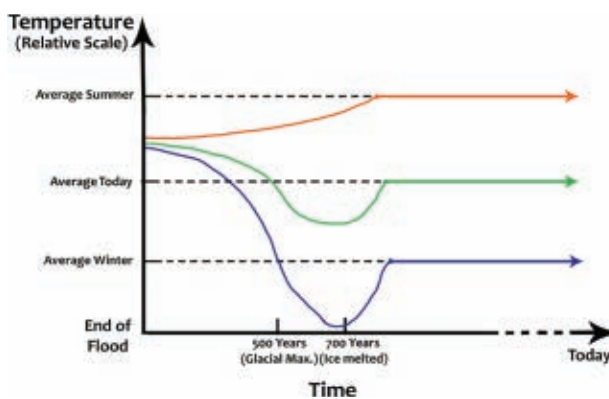
Most sulfuric acid aerosols<sup>23</sup> from volcanic and meteorite impacts associated with the Flood would have ended up in the stratosphere after the Flood. They would take a few dozen years to sink to the ground. The higher the aerosol rises in the stratosphere, the longer it remains there.<sup>24</sup> As the Flood aerosols sank, they would likely have been replaced by continuing post-Flood volcanism, which most likely continued for hundreds of years until Earth reached a near equilibrium—a climate similar to the present day. These aerosols would probably change the climate because some of the sunlight would be reflected into space, not absorbed at the surface, and would thus cool the land (figure 4). This cooling would have likely affected the summers the most. At the same time, there were processes in the ocean and atmosphere that likely resulted in warmer winters. The oceans would probably have been less affected because of their large heat capacity. Moreover, the reflectivity (albedo) on the continents would have been much higher than today because of much barren land, high reflectivity volcanic ash on barren ground, and snow, which has a much higher albedo than old and/or dirty snow (table 1).

Cool summers and warm winters are called an *equable* climate, and in many locations during the early-to-mid Ice Age the seasonal temperature changes would most likely have been slight, except over the developing ice sheets. Figure 5 shows the projected average winter, summer, and annual temperatures with time for the Northern Hemisphere mid- and high-latitude continents from the end of the Flood until today. Figure 6 shows the projected annual mid- and high-latitude Northern Hemisphere precipitation with time from the end of the Flood until today. This unique climate early in the Ice Age is indicated by the ubiquitous disharmonious associations of plants and animals in which warmer climate organisms are found in Ice Age debris with colder climate organisms.<sup>28</sup> The uniformitarian ice age climate model predicts a very cold winter and summer, one that is far colder than today. Disharmonious associations would be impossible in such a climate.

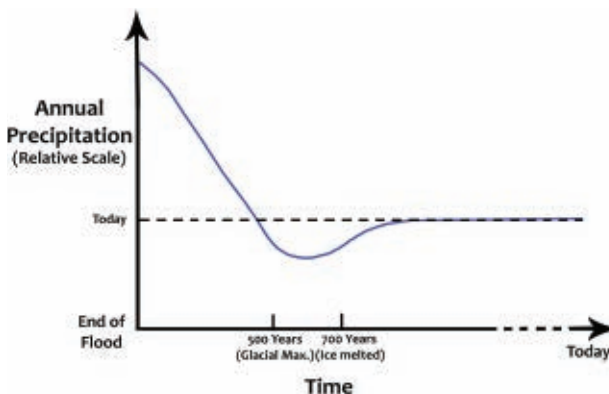
The oceans after the Flood would probably have been warm from surface to bottom and pole to pole. This vast amount of heat would cause immense evaporation, which

**Table 1.** Albedos over various surfaces in percent of solar radiation reflected back to space<sup>25–27</sup>

Surface	Albedo (% reflected)
Planet as a whole	~30%
Sand	18 to 28%
Grass	16 to 20%
Forests	14 to 20%
Dense forests	5 to 10%
Fresh snow	75 to 95%
Old snow	40 to 70%
Debris rich ice	6 to 30%
Debris rich firm snow	15 to 40%
Clean ice	30 to 46%



**Figure 5.** The average winter, summer, and annual temperature with time for the Northern Hemisphere mid- and high-latitude continents from the end of the Flood through the Ice Age to today (drawn by Melanie Richard)



**Figure 6.** The annual mid- and high-latitude Northern Hemisphere precipitation with time from the end of the Flood through the Ice Age to today (drawn by Melanie Richard)





**Figure 7.** Steam fog from a 3-acre warm pond in early autumn near to the author's house



**Figure 8.** Column from Carlsbad Cavern, New Mexico

likely caused about 75% of the cooling of the oceans. The other 25% was from infrared radiation loss and by contact of cooler air with warm water. It would have been similar to what happens in the fall when cooler air flows over a pond warmed from the summer heat (figure 7). This strong oceanic evaporation would have provided the abundant snow for a rapid Ice Age with abundant rain over most of the rest of Earth. Heat liberated by the oceans would have warmed the air above the oceans. When water vapour condenses, it gives off a large amount of latent heat to the atmosphere. Thus, Ice Age winters would likely have been much warmer at mid and high latitudes early and midway through the Ice Age than today. Indeed, apart from the reflectivity of sulfuric acid aerosols, barren ground, volcanic ash on the ground, and snow cover, the warmth of the oceans would probably

have swamped the summer continental cooling.<sup>29,30,31</sup> This unique climate is the most probable consequence of the Genesis Flood.

When we consider the Flood and the unique Ice Age climate following it, most of the variables are in place for much faster growth rates of speleothems than currently recorded. It is impossible to know exactly how much each variable would have increased speleogenesis compared to today's rates, but I will provide estimates founded on my professional training associated with my position as a weather forecaster for the National Weather Service for 30 years. These estimates (educated guesses) are used mainly to give us an idea of the significance of each variable towards growth of speleothems and are recognized as ballpark estimates.

### Very high soil $\text{CO}_{2(\text{aq})}$ and cave $\text{Ca}_{(\text{aq})}^{2+}$

The amount of  $\text{Ca}_{(\text{aq})}^{2+}$  that drips down into the cave from the carbonate above depends strongly on the soil's  $\text{CO}_{2(\text{aq})}$ ,<sup>32</sup> and the climate would be especially important for this variable.<sup>33</sup> The early-to-mid post-Flood Ice Age climate would be very moist, almost everywhere. Rough calculations, based on the warm western Pacific Ocean, suggest that the semi-arid south-west US would have received about four times as much precipitation as today.<sup>34</sup> With much more precipitation, trees and plants would grow profusely, and the soil would be thicker.<sup>33</sup> Since an intermediate amount of soil moisture is ideal (see part 2), the soil may have become too wet at times, retarding speleogenesis. However, in carbonate terrain, drainage should be optimal down through the joints and faults and would prevent the soil from becoming saturated, except momentarily in heavy rainstorms.

The equable early-to-mid Ice Age climate would have greatly aided the growth of soil  $\text{CO}_{2(\text{aq})}$  since photosynthesis would continue through the winters and at low-to-mid latitudes. Cooler summers would retard growth some, but in many low-to-mid latitude locations cooler summers would cause less soil evaporation, aid photosynthesis, and generate abundant soil carbon dioxide. Vegetation would flourish under these ideal conditions, so the soil's  $\text{CO}_{2(\text{aq})}$  would be very high at low-to-mid latitudes while the high latitudes were mostly covered by ice sheets. The warmer and wetter climate south of the ice would promote dense vegetation and high soil microbial activity.<sup>35,36</sup> Soil  $\text{CO}_{2(\text{aq})}$  could be 1.5–3 times as great from Ice Age temperature and moisture alone, especially at low latitudes and unglaciated mid-latitude locations.

Soil thickness is another variable for the formation of  $\text{CO}_2$ . After the floodwater drained, there would be areas of thick mud and vegetation in various stages of decay. This rich matrix would be ideal for re-establishing the world's flora, which in turn improved and developed the thickness



of the soil. Immediately after the flood-water drained, mud would likely have high soil organic matter (SOM) from the pulverized pre-Flood biosphere. It would also tend to be thicker in *low spots* in the terrain. The SOM from the Flood would likely have lasted from decades to centuries.<sup>37</sup> Cave experts Carol Hill and Paolo Forti noticed that the largest columns in Guadalupe Mountains caves, including Carlsbad Caverns (figure 8), *were aligned along ceiling joints and that a valley existed above the columns on the surface*:

“Typically, the largest columns are aligned along ceiling joints, where the greatest amount of water is dripping into a cave. Hill (1978c) correlated the location of the most massive columns and stalagmites in Ogle Cave, New Mexico, with a valley on the surface overlying the cave. The joint along which the valley had developed is the same as that along which the massive travertine developed.”<sup>38</sup>

The columns in Ogle Cave in the Guadalupe Mountains are as high as 20 m and are among the largest in North America.<sup>39</sup> For instance, above the Sequoia room in Ogle Cave is a topographic low: “Drainage is pilfered from this low down into the cave along major joints and minor cross joints”. If the valley above Ogle Cave was overlaid with organic mud, it would add much more calcite to the speleothems as the water drained through the abundant joints. This could add another growth factor of 1.5 to 3 times in the soil  $\text{CO}_{2(\text{aq})}$ , creating a unique condition for the rapid formation of columns.

This mud left by the floodwaters would also be the source of the sand and silt for the immense amount of loess during the Ice Age, after the climate dried at the end of the Ice Age. Mud or soil that remained in pockets above the caves after the Flood could have mostly blown away late in the Ice Age.

Thicker soil laced with organic matter, thriving vegetation, and much more moisture, all combined with an equable, mild climate early and midway through the Ice Age would *multiply* the amount of  $\text{Ca}_{(\text{aq})}^{2+}$  from the soil  $\text{CO}_2$ . As such, the growth rate could be 2 to 9 times that of today.

These conditions would explain why the many caves in the Guadalupe Mountains, for instance, including Carlsbad Caverns, have such large speleothems. It is well known that the climate is too dry today, winters too cold, and the soil and vegetation too sparse to result in much soil  $\text{CO}_{2(\text{aq})}$  and drip water calcium. That is why very few speleothems in the Guadalupe Mountains are growing today.<sup>39</sup> In fact, practically all the speleothems are considered relic or ‘dead’, and



Figure 9. Huge gypsum crystals from the Cave of the Swords, Naica, Mexico

Image: Alexander Van Dreische/CC-BY-SA-3.0

supposedly grew during wet ‘glacial’ periods over a period of about 4 million years.<sup>16</sup> It is doubtful that a uniformitarian ice age, one that the models say was much colder and drier than today, would provide the needed moisture. It is a contradiction that uniformitarian scientists have not faced. But the Guadalupe Mountains caves can be explained by the unique post-Flood Ice Age climate.

The period of rapid growth would stop by the end of the biblical Ice Age because the climate would change to be drier than it is today with much wind, colder winters, and drought. The vegetation and soil above the caves would mostly disappear with the wind.

### Cave temperatures would increase growth rates early in the Ice Age

Moreover, the carbonate rock would be quite warm at the end of the Flood. This too would contribute to the growth of speleothems. Late in the Flood, runoff eroded hundreds and in some cases thousands of metres of sediment and rock from the continents.<sup>40</sup> Since temperatures increase downward, today about  $30^{\circ}\text{C}/1,000\text{ m}$ , the resulting carbonate rock would be very warm to hot right after the Flood with increasing temperatures downward. Since the growth rate of speleothems is proportional to cave temperatures, hot rock would increase growth rates early in the Ice Age. The rock would eventually cool by conduction from the surface and by cave ventilation, but the cooling would be retarded some by the high upward heat flow in the rock. High temperatures could cause speleothem growth to be about 1.5 to 3 times that of today for probably a hundred years or so after the Flood. Evidence for high cave temperatures is shown by the huge

**Table 2.** Postulated increase in speleothem growth rate early-to-mid Ice Age based on the main growth variables

Variable	Estimated enhanced growth over today
1) Equable temperature and more moisture	1.5 to 3 times
2) Thicker soil and more vegetation	1.5 to 3 times
3) High cave temperatures	1.5 to 3 times
4) Greater ventilation	1.5 to 3 times
5) Much faster drip rate	2 to 6 times
6) Thicker water film	1.5 to 3 times

gypsum crystals in the Cave of the Swords in Naica, Mexico.<sup>41</sup> These crystals are up to 12 m long, 4 m wide, and weigh 55 tones (figure 9). The estimated temperatures of growth, based on fluid inclusions, are 47° to 54°C (117° to 129°F).

Accepting a global Flood and an Ice Age following it greatly improves our understanding of Earth's history. In so doing we can find explanations for questions that uniformitarian scientists are unable to answer and solve challenges to our model posed by them.<sup>42</sup>

### Cave CO<sub>2</sub> would aid speleothem growth

Another variable affecting the growth rate of speleothems is greater cave ventilation. Within the Flood paradigm, cave ventilation would be expected to be much stronger than it is today. This would be the case especially early in the Ice Age. It would be driven by the warm temperatures of the carbonate karst, which would continually vent to the cooler atmosphere by convection. Ventilation would not only lower the cave CO<sub>2</sub> but also the relative humidity for speleothem growth by evaporating water. Moreover, the year-round increased storminess and wind in at least the mid latitudes would also aid ventilation. Therefore, greater ventilation may have aided the growth of speleothems by more rapid degassing of CO<sub>2</sub> by something like 1.5 to 3 times that of today. A decrease in relative humidity could cause another 50% increase in speleothem growth if Carlsbad Caverns today can be used as an analog of what a little lower relative humidity can do.

### Cave drip rate increased during the Ice Age

There is little doubt that the drip rate is a significant factor. Hill and Forti in the quote above noticed a correlation with columns below ceiling joints and copious dripping water.<sup>38</sup> Precipitation during the early-to-mid Ice Age would be much higher than today, practically everywhere unglaciated. This water highly charged with CO<sub>2(aq)</sub> would cause abundant drip

water, and speleothems would be expected to grow much faster from just this variable, perhaps 2 to 6 times as fast.

### Water film thickness increased during the Ice Age

The water film thickness on speleothems is a significant factor in their growth. The thicker the water film the greater the deposition of carbonate on speleothems. With the additional drip water, the film thickness dripping from the ceiling and stalactites onto stalagmites would increase. So, it would be significantly greater early-to-mid Ice Age than the assumed 0.1 mm a year, the value considered today. Additionally, the faster the drip rate the wider the stalagmite.<sup>43</sup> This would likely cause a decrease of the convex upward radius of curvature resulting in a thicker water film. These considerations may result in another 1.5 to 3 times the growth rate.

### The net result

Combining all of the above leads us to conclude there is potential for tremendously rapid growth of speleothems in some caves and in some areas of the caves during the early-to-mid Ice Age. Some could have easily grown over 100 times the rate of today. The observation of a growth of 30 cm/yr for 3 years could be typical of some locations. It is not difficult to see how huge speleothems, especially the columns, could have grown in just 300 years following the Flood. Table 2 summarizes the variables that would enhance speleothem growth rate in the early-to-mid Ice Age.

The rate of growth would slow as the Ice Age progressed and probably reach close to today's slow growth rate or less by late Ice Age. Increasing storminess would result in greater ventilation, partly offsetting the other variables that would slow growth.

### Conclusion

Rapid Flood uplift would result in much faulting of carbonates. Water draining through these fractures would become charged with sulfuric acid and cause rapid formation of the cave openings, as summarized in part 1. Five main variables determine the rate of speleothem growth, and these were discussed in part 2. In this part, I applied those variables from part 2 to the after-effects of the Flood and the rapid, post-Flood Ice Age to provide rough estimates of how each variable can result in faster speleogenesis. The Flood and the post-Flood Ice Age are keys to solving the time challenge of caves.

We have the potential of providing reasonable answers to many other time challenges presented by uniformitarian scientists. However, it takes much literature research; field work; and an understanding, as much as possible, of the geological and geophysical effects of the Flood and the post-Flood Ice Age.

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# Circadian rhythms and creation

Warren Shipton

A large number of organisms possess operational systems that vary in intensity in a rhythmic manner over a 24-hour period. These circadian rhythms usually are entrained by light and are vital for the robust functioning of the organism. The immediate interest for us is the origin of the regulatory system underlying circadian rhythms. The regulatory systems responsible for rhythmic phenomena can be complex, especially in plants and animals. No transitional schemes can be constructed to explain the emergence of the more complex systems from the simpler ones found in bacteria on account of lack of homologous features conserved across the kingdoms. In laboratory experiments, considerable design input is needed to construct the simplest artificial biological clock; these do not run on a 24-hour cycle. The existence of circadian clocks, with fundamental common design elements, specified complexity, and functional coherence, argues for the existence of a designer.

Many biological processes show regular self-sustained cycles of approximately 24 hours. These are termed circadian; the cycles are regulated by cellular clocks. The features that usually are taken to characterize circadian clocks are that they operate on a self-sustaining basis and show approximately 24-hour oscillations under continuous conditions of either constant light or darkness. Genuine rhythms show temperature compensation—stability of the rhythm over a range of temperatures. Circadian rhythms have been observed from photosynthetic bacteria, fungi, insects, and plants, to mammals operating under natural conditions.<sup>1,2</sup>

Diurnal rhythms in plants have been known from ancient times (400 BCE). These rhythms, now recognized as circadian, synchronize various physiological functions to the 24-hour rotational cycle of the earth. Much later, unicellular bacteria and eukaryotes, including humans, were shown to possess circadian clocks.<sup>3</sup> We understand that temporary disturbances are adjusted readily, as indicated by recovery from jet lag in humans.<sup>4,5</sup>

## Significance of clocks

The clocks have significance to all forms of life possessing them. In mammals the daily clocks regulate a range of functions and behaviours, from cell division to blood pressure, hormone release, digestion, immune function, and cognition. In these organisms there is a master clock and each of the cells has an independent clock.<sup>3,6</sup>

Disturbance of the circadian clock can lead to some serious outcomes. Experimental animals subjected to disruption of the circadian clock through mutation or deletion of the appropriate genes show altered physiology and behaviour. Pathologies may develop, such as metabolic dysfunction, cancer, premature ageing, cardiovascular, and renal abnormalities.<sup>7</sup>

In one large study in humans (433,268 adults), lifestyle differences were analyzed. The contrast was between those individuals where activities (work and social) were organized for the evening (late timing of sleep and generally shorter sleep durations), with those possessing a morning emphasis and early sleep appointments. An increased risk of mortality was shown in the evening types with an elevated risk of cardiovascular events, diabetes, and psychological, neurological, respiratory, and gastrointestinal disorders.<sup>8</sup> Disruption of circadian rhythms through lifestyle choices and light pollution can change the rhythmic levels of circulating melatonin and cortisol in the body and also interrupts the rhythms in bone growth leading to weakened bones.<sup>9,10</sup> Credible evidence is accumulating to suggest that both the rate of ageing and the progression of some age-related diseases are related to the disruption of circadian rhythms and melatonin levels.<sup>10</sup>

Certain mental illnesses are associated with the disruption of the circadian cycle. The strategy of resetting it by forced regulation of sleep may result in a reduction of psychotic episodes in about half of schizophrenia patients. Not only is disease progression faster when schedules are not synchronized to the internal clock, but also the effectiveness of certain drugs may be time-of-administration dependent.<sup>11</sup>

## The minimal clock in cyanobacteria

Cyanobacteria possess a relatively simple circadian clock consisting of three essential components (this contrasts with a component rich scene with the so-called higher organisms). Similar photosynthetic prokaryotes are considered to have played a critical role in evolution of the plastid. Evolutionists presume that ingestion of a cyanobacterium took place by a mitochondrion-containing eukaryote, leading to the evolution of plastids as a consequence of the endosymbiotic relationship thus established.<sup>12</sup>

Now cyanobacteria contribute to the maintenance of an oxygenic environment, but the clocks allowed adaptation to fluctuations in the environment. These organisms possess a minimal time-keeping system regulated by a small cluster of genes. The circuitry responsible for the oscillations is a post-translational circuit type.<sup>13</sup>

The clock system involves an oscillator that is connected with the timing loop. An input pathway is present for sensing environmental signals and transmitting them to the oscillator, and an output pathway also exists that transmits information from the oscillator to influence cellular activities.<sup>14</sup>

**Oscillator and timing loop.** The timing clock in the cyanobacterium *Synechococcus elongatus* and a few other cyanobacteria consists of three proteins (KaiA, KaiB and KaiC) encoded by the *KaiABC* gene cluster. A genuine circadian clock operates in such organisms, as the oscillator can be reconstituted *in vitro* when the three purified proteins are in the presence of ATP. The stable oscillations shown are of 24-hour duration. Moreover, the pacemaker operates on a 24-hour cycle despite the fact that the generation time of the organism can be as short as 5–6 hours. Remarkably, the clock of the daughter cell operates in phase with that of the mother cell.<sup>15</sup>

A key gene regulates KaiC protein production that goes through oscillations in phosphorylation to initiate circadian rhythms. KaiC undergoes autophosphorylation during the day in the presence of adenosine triphosphate when stimulated by KaiA (figure 1). At night autodephosphorylation occurs when KaiA is inhibited by KaiB. This process takes hours to complete. The cyclic nature of the phosphorylation states is vital. However, the processes involved in the operation of this cycle are far from simple. In fact, there are detailed conformational changes involved in the interactions that occur among the Kai proteins. It has been shown that the key protein in the cycle, KaiC, the central pacemaker, undergoes a slow tightening and loosening of a particular ring structure following autophosphorylation. This gives KaiA and KaiB proteins access to specific binding domains on KaiC. It is noted that the tight binding aspect is vital to the success of the process. Nevertheless, there is competition for binding sites among other components of the system and KaiB must also undergo conformational changes to allow the formation of the KaiB-KaiC complex. Overall, the changes, which are quite detailed, allow the clock to measure time between sunrise and sunset.<sup>11,16,17</sup>

The circadian oscillation of KaiC phosphorylation can be enabled *in vitro* as indicated previously. This shows that a transcription/translation feedback loop is not essential to the circadian oscillation mechanism. The oscillator functions independently of transcription. However, a regulatory feedback loop is essential for normal growth in the natural environment as it links the post-translational oscillator to the transcription machinery (figure 1).<sup>18</sup>

**Input pathway.** Environmental cycles entrain the circadian clock. This means that a dark pulse intervention in an

otherwise environment of continuous light will reset the clock. One key protein associated with the input pathway is circadian input kinase (CikA) that monitors the redox status of cells and light intensity.<sup>14</sup>

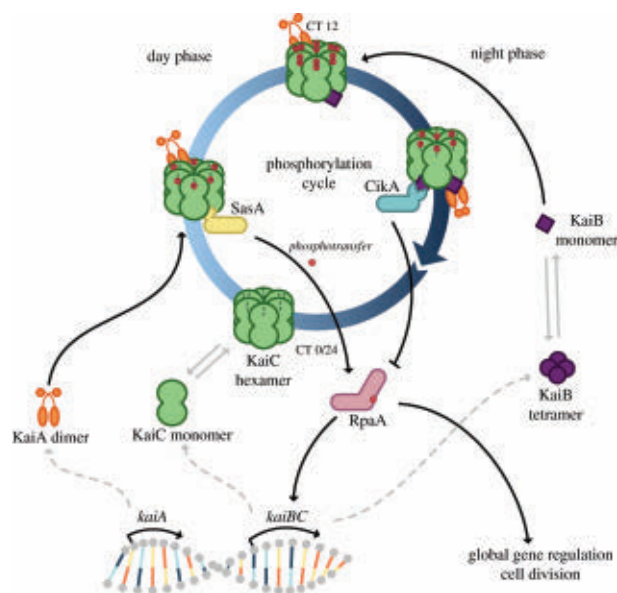
**Primary output pathway.** The expression of the circadian genes (*kaiBC*) centres on the histidine kinase SasA and a response regulator protein, RpaA, which can bind to DNA. The histidine kinase autophosphorylates following KaiC binding. The phosphate is then transferred to the master regulator RpaA, which is the transcriptional activator. The operation of this system is necessary for normal growth of the cyanobacterium. Secondary output pathways have also been identified.<sup>18,20</sup>

## Complex clock in plants

Plants live in an environment that changes on a regular basis as day follows night. The environmental changes associated with the rotation of the earth are linked with many rhythmic phenomena in plants.

As in the cyanobacteria, circadian clocks in plants involve an input pathway (photoreceptors), a circadian clock mechanism, and output pathways giving rise to rhythmic behaviour (figure 2).

In contrast to the relative simplicity found in the cyanobacteria, the situation in land plants is complex. Multiple



**Figure 1.** Circadian clock operation in *Synechococcus elongatus*. Protein KaiC is the central oscillator. Its phosphorylation state determines its interaction with other key proteins (KaiA and KaiB). KaiC autophosphorylation is stimulated by KaiA. Fully phosphorylated KaiC interacts with KaiB, which then initiates loss of phosphate. KaiC drives the transcription of the *kaiBC* operon through the phosphorylation of the histidine kinase SasA and the DNA binding protein RpaA. A negative feedback loop in the process is driven by a bacteriophytochrome protein, CikA, and involves repression of RpaA activity.<sup>19</sup>

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photoreceptors (phytochromes and cryptochromes) have been identified and there are also sensors for other stimuli. Instead of one central post-translational oscillator, as in cyanobacteria, oscillation in gene expression is achieved through transcription-translation feedback loops.

The circadian clock consists of interconnected feedback loops (positive and negative—figure 3). The interlocking system found in the model plant used in research, *Arabidopsis*, is very complex, surpassing the complexity found in fungi and animals. More than 20 interlocking transcriptional feedback loops are involved in contrast to the relatively few found elsewhere in eukaryotes. This is postulated to have evolved to give such sessile organisms the ability to contend with environmental extremes.<sup>21,22</sup>

### How did the clocks arise?

Circadian clocks often are very complex as noted in the last section. Explaining the necessity for such clocks has been challenging. Although a raft of supposed evolutionary benefits can be listed for organisms possessing these clocks, the list can be shortened. The primary basis for circadian clocks presumably resides in the resistance to environmental fluctuations it gives to organisms.<sup>3</sup>

The construction of even a rudimentary oscillator can be challenging. Elowitz and Leibler were able to construct a rudimentary oscillatory network using components found naturally in other situations.<sup>23</sup> This they accomplished by constructing a plasmid with three repressor components, which gave a periodicity in the delivery of a product (green fluorescent protein) of around 150 minutes when inserted into *Escherichia coli*. Although the plasmid was transmitted from generation to generation, the variation in periodicity between cells could be considerable. This surely indicates the difficulty of constructing a viable scheme for the emergence of oscillatory systems through chance events.

In Elowitz and Leibler's feedback loop, each gene produced a protein that repressed the next gene in the loop. The repressor network constructed involved first LacI from *Escherichia coli*. This repressor protein inhibited the transcription of the second repressor gene *tetR*. Its protein product inhibited the expression of the third gene, *cl*. And, finally, CL protein inhibited *lacI* gene expression. There was an irreducible complexity to the working of the clock. Since this work involved synthesizing a regulatory network, it follows that there was a predictable, minimal design aspect involved. Indeed, the authors held that improving the design of such artificial systems might allow an understanding of the 'design principles' needed for the clock to work in evolved organisms occurring naturally. Interestingly, a set of three inhibitory interactions of a regulatory nature are noted as being critical to keep the network rhythmic in mammals. In this respect, the design is like that used by Elowitz and Leibler in their synthetic repressilator. A similar motif has been suggested as functioning in plants.<sup>23,24</sup>

Bearing in mind that eukaryotes show circadian rhythms, it is reasonable to anticipate some similarity in genome structure driving this function among the simpler organisms from which they allegedly arose. None of the Kai proteins identified in prokaryotes shows sequence similarity with proteins found in eukaryote clocks. Also, extensive analysis has shown that components in archaea, bacteria, and cyanobacteria (prokaryotes) responsible for rhythmic genes differ substantially, with KaiA protein often lacking and with differences in input and output mechanisms being noted.<sup>25,26</sup>

Homologs of *kaiB* and *kaiC* genes have been found in a number of prokaryote genomes, but their function is not understood beyond suggesting that having these genes confers some type of enhanced adaptive fitness. However, no eukaryotic organism carries Kai proteins, making the creation of meaningful links with this putative group of prokaryote ancestors difficult.<sup>14,25,27</sup> Significantly, the circadian clock in the cyanobacterium *S. elongatus* functions as a post-translational oscillator where the association of KaiA and KaiB drive phosphorylation of KaiC, which is an auto kinase, phosphorylase, and ATPase. A feedback loop has been identified regulating the phosphorylation state of key proteins. This is essential for normal growth in the natural environment as it links the post-translational oscillator to the transcription machinery. This process differs somewhat from that seen in plants and animals. There, clock operation is via interlocking transcription-translation feedback loops. However, some post-translational control of circadian activity is involved in plants, fungi, and animals.<sup>1,28,29</sup> This means that many organisms possess circadian clocks that use both transcription-translation and post-translational steps to enable functioning in the natural environment.<sup>30</sup>

The emergence of circadian clocks, as seen in eukaryote cells, demands the presence of compartmentalization. The existence of membranes hence is vital in that this allows separation of reactants and products and also provides for events to happen at different times.<sup>11</sup> Explaining the emergence of complex clocks found in plants and mammals requires the sorts of developmental gymnastics typically invoked in many evolution accounts. Evolutionists contend that the Archaea, or the new archaeal phyla placed in the kingdom Protoarchaeota, holds the ancestor of the eukaryotes. The Archaea contain what are considered ancestral versions of signature systems involved with phagocytosis currently found in the eukaryotes.<sup>31</sup> It is contended that a wall-less organism of archaeal lineage accidentally engulfed an alpha-proteobacterium initiating the creation of eukaryotes.<sup>32,33</sup>

The initial endosymbiont subsequently evolved into an organelle, the mitochondrion, that membrane-bound organelle characteristic of eukaryotes and essential for energy generation. The plastids similarly are considered to have evolved through an endosymbiotic relationship, this time with a cyanobacterium. The ingestion of this bacterium was by a mitochondrion-containing eukaryote.<sup>34</sup> More than 20 theories have been generated to account for the origin of eukaryotes



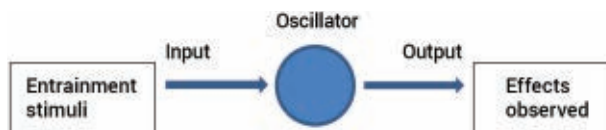
from bacteria. This means that there is massive uncertainty about the most fruitful line of enquiry in which to engage. Perhaps understandably, some researchers have labelled the work of others as ‘entertaining fantasy’ or ‘research gone astray’. Nothing is settled.<sup>35,36</sup> It is admitted that there is no direct evidence to support any of the possibilities suggested.<sup>37–39</sup> This leaves the question of origins of circadian rhythms in the arena of speculation.

If the alpha-proteobacteria are considered as ancestors of the mitochondrion, it would be also logical to look at this group as contributing something to the development of a circadian clock in the eukaryotes. The results also have been disappointing; no evolutionary homology has been found. Selected purple bacteria (alpha-proteobacteria) do show periodic gene expression. In *Rhodobacter sphaeroides*, rhythmic gene expression has been found driven by the oscillatory protein KaiC. It appears that a KaiBC-based system is able to drive circadian-like rhythms in this organism, which shows a period of 20.5 hours in the transcription of the *aidB* gene.<sup>1</sup> The situation is no better in a member of the group thought responsible for engulfing the alpha-proteobacterium. For example, in *Haloferax volcanii* (an archaeon), a KaiC-related system operates to enable a light-dark-dependent response (rhythmic) from a number of genes, but it fails to satisfy the full requirements to give it genuine circadian status. The genes (*cirA* to *cirD*) code for proteins that showed sequence similarities to the KaiC protein (28 to 55%) and also contain motifs characteristically found in KaiC proteins. When other haloarchaeal genera are considered, homology among the clock proteins is disappointingly low (25 to 30%).<sup>1,40</sup>

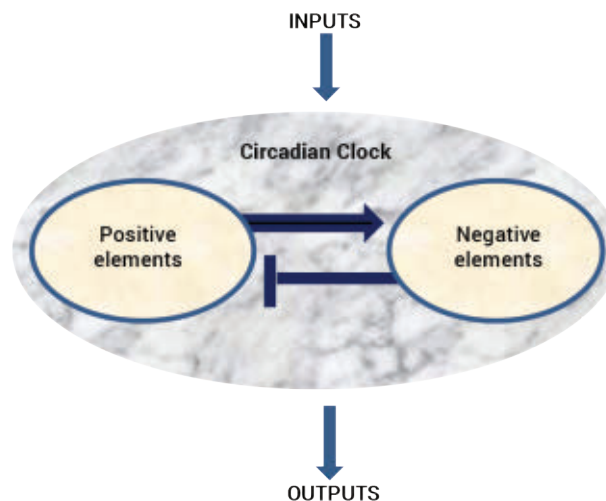
It is apparent, then, that the clock components are not conserved across the kingdoms. This has led to the conclusion that clocks seen in the different phylogenetic kingdoms arose separately.<sup>41</sup> It is not even known how the simplest of cyanobacterial circadian clocks arose. Speculative schemes have been invented, but nothing rests on solid ground.<sup>42</sup>

### Critical observations

The common features noted in circadian clocks, other than the points outlined by definition, are that they possess some type of oscillator which is responsive to environmental inputs and it delivers a variety of outputs. This means that a basic design is evident. On a deeper level, there are enormous differences seen among the kingdoms, with transcriptional-translation feedback loops characterizing the eukaryotes and post-translational circuitry the prokaryotes. However, both groups have feedback loops and post-translational mechanisms somewhere in the operational system. Again, on the broad-organizational level, design aspects are noted. At a theoretical modelling level, two basic design principles appear to exist, namely: a) well-defined phosphorylation states exist and are associated with rate constants that ensure unidirectional movement [phosphorylation (e.g. kinase) to dephosphorylation (e.g. phosphatase)], and b) oscillations



**Figure 2.** Conceptual scheme showing the flow of information in circadian clocks<sup>21</sup>



**Figure 3.** Positive and negative interlocking feedback loops characteristic of circadian clocks in most organisms<sup>21</sup>

of single molecules are synchronized by tight binding of enzyme by a substrate meaning that the enzyme is depleted before competing reactions occur.<sup>16</sup>

The transition from a cyanobacterial clock (simplest) to that of a photosynthesizing eukaryote (most complex) presents enormous challenges. The lack of clock component conservation across this divide has led some to conclude that the evolution of the clock in each major group occurred independently. However, no reasonable scenario has been constructed to account for these events. In addition, looking back billions of years, to when cyanobacteria are considered to have arisen, the day-length is thought to have varied from 11 hours to what is observed today, requiring further adaptation.<sup>43</sup> This undoubtedly would be explained by evolutionists by recourse to mutational changes, which have been found capable of altering (shortening or lengthening) the circadian rhythm length.<sup>44,45</sup>

### Fitting the clock into the creation account

The biblical record has the green plants arising on Day 3 of creation. We suggest that the simplest (cyanobacterial) and most complex clocks were created in their respective living systems on that day. The archaea and bacteria (non-photosynthetic) possibly were created on Day 2. Light from the sun, as we know it, came on Day 4, providing the principle entrainment stimulus, light. On Days 5 and 6 the sea creatures, mammals (including humans) were created rounding out the picture. In this account there is a logical division

among the eukaryotes. The most complex clock systems were created on Day 3 and the less complex on Days 5 and 6, with some design similarities observed. From an evolutionary viewpoint, the progression from a more complex to less complex organizational and functional clock system over time represents an anti-intuitive progression, as plants appeared before animals. However, this does not constitute a problem in the creation account for plants have the most varied operational arrangements in response to light. When considering animals with regard to other operational systems, such an analysis indicates that they outclass plants in operational complexity. Indeed, they have their own novel systems.

The 24-hour length of circadian clock cycles fits into the creation account. The Hebrew word for day is *yom*. It appears regularly in Genesis 1 (verses 5, 8, 13, 19, 23, 31) to describe what was accomplished on each day of creation. Whenever a definite number (e.g. first, second, etc.) is associated with the word ‘day’ in Hebrew literature, the time period is 24 hours.<sup>46</sup> A strong argument cannot be made for the creation days being 24 hours in length by reference to the periodicity of circadian rhythms commonly observed today. This is on account of the observation that mutations may alter the circadian rhythm length.<sup>44,45</sup> Nevertheless, it is observed readily that there is no contradiction between the biblical text and the periodicity of the rhythmic cycles we now observe. It constitutes an observation favouring belief in the Word of God.

We have noted already that some common design features are noted across all biological clocks. The specified complexity concept is also involved for the system must run repetitively to reflect compliance with the earth’s rotational cycles of 24 hours. Furthermore, all the parts contribute to the outcomes, in other words, functional coherence is observed. Such coherence cannot be explained in the absence of an intelligent agent being involved.<sup>47</sup> The complexity observed in the so-called higher organisms indicates that they possess robustness,<sup>22</sup> a feature particularly valuable post-Fall.

While in everyday life it is accepted that evidence of design and functional complexity is indicative of an intelligent Designer, this same observation is not readily admitted when scientists seek to explain origins in the natural world. In commenting on such a stand, it has been observed that if the designers of the Search for Extraterrestrial Intelligence (SETI) program took the same attitude, then there would be no purpose pursuing the project.<sup>48</sup> This project represents a serious search for life elsewhere in the cosmos and initially the search is for narrow band radio signals from outer space. The existence of such signals or the detection of laser flashes from planets in the galaxy would be taken as proof of extraterrestrial life.<sup>49</sup>

The idea of design and a designer are powerful concepts that appeal to the Christian dedicated to believe in God’s revelations as did the apostle Paul. He said: “For since the creation of the world His [God’s] invisible *attributes* are clearly seen, being understood by the things that are made, *even* His eternal power and Godhead, so that they [those

who do not believe in God] are without excuse” (Romans 1:20, NKJV). It should be noted that even Charles Darwin could not accept entirely the idea that the world we see is the result of blind chance or of necessity. Even for him some design was evident.<sup>50</sup>

## Conclusions

Interpretation of the biblical text, using the historical grammatical approach, leaves a firm conviction that creation was accomplished in six literal, 24-hour days. This contrasts with all other ideas circulating today. The creation of the sun and moon and hence the dark/light cycle regulated by astronomical markers on Day 4 of Creation Week was momentous. This event was preceded (Day 3) by the creation of plants and followed by other living forms on Days 5 and 6. The ancient roots of the 24-hour dark/light cycle instituted at creation are believed to be reflected in the periodicity shown in the circadian rhythms found in almost all living things.

Elucidation of the biochemical events associated with circadian rhythms has been challenging even in unicellular organisms. Three proteins are involved in oscillator construction (post-translation oscillator) in simple organisms such as cyanobacteria, but in plants and mammals the cycles are intricate, and the circadian clocks are based on transcription-translation feedback loops. Nevertheless, there are basic design patterns that can be traced throughout all life forms. These involve both post-translation circuitry and stimulatory and inhibitory activities in feedback loops over a 24-hour period. In feedback loops, each gene produces a protein that repressed the next gene in the loop. In plants and mammals there are many proteins involved and the interactions are complex. We think that these design principles and the irreducible complexity shown in the simplest synthetic regulatory network confirms the reality of the creation account. The complexity of the cellular and biochemical events associated with circadian rhythms cannot readily be accounted for by a model of origins other than one involving an intelligent designer.

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# The hemizygosity hypothesis—a novel genetic paradigm for baranomes

Peer Terborg

Heterostyly is a fascinating feature of the flowers of a variety of plant families. It both helps to promote sexual reproduction and prevents inbreeding. In the most common form of heterostyly, plants develop either flowers with a short style and long stamens or with a long style and short stamens. The fact that in nature only plants with either of both phenotypes are observed suggests that only one gene is involved. However, a peculiarity is that several clearly defined characteristics (style length, stamens length, pollen size) are simultaneously expressed, indicating the presence of at least three genes. Recent molecular genetics demonstrates heterostyly is determined by a single genetic locus with five genes, which is inherited as a single, so-called ‘supergene’. Interestingly, only one of the parental chromosomes delivers the supergene to the offspring, thus the trait is present in a hemizygous state. This observation can be taken as a novel genetic paradigm to understand how potential, useful traits could be cryptically present in baranomes, i.e. the undifferentiated and uncommitted genomes of created kinds.

Flowering plants have complex reproductive structures. The pollen-producing male part is called the stamen and is usually composed of a filament and an anther. The filament, when present, holds up the anther, which produces pollen. The pollen-receiving female part is called the pistil. This is usually divided into three sections called the stigma, style, and ovary. Upon close examination, the flowers of primroses appear as two distinctly different types. Some flowers have long styles and short stamens; others have short styles and long stamens. The combination of a long style with short stamens is called the *L*-(long) phenotype, whereas the combination of a short style with long stamens is called the *S*-(short) phenotype (figure 1). In botany, this dimorphism is called heterostyly—a phenomenon described by Charles Darwin. In 1860, Darwin wrote a series of letters to his friend and confidant J.D. Hooker and to the botanist J.S. Henslow. He had studied two primrose species and reported that these consistently produced two types of flowers. Both species existed in two forms of approximately equal numbers, which appeared to be ‘male’ and ‘female’. The stamens in the supposed ‘female’ form had very short filaments. It also produced small elongated pollen grains, and the pistil had a long style with long stigma papillae. In the supposedly ‘male’ form, he reported “long filaments, large round pollen grains, and a short pistil with short papillae”.

Darwin recognized that the different types of flowers represented different reproductive systems, which he called ‘distyly’. He correctly argued that both flower types were hermaphrodites and that “the pollen of A is adapted to the stylus of B, and vice versa”. In the following years, Darwin published his observations on heterostyly, especially its occurrence in flax (*Linum*) and willow (*Lythrum*). In 1877,

he compiled his research on heterostyly in the book *Different Forms of Flowers*. As a result of this work, Darwin is widely recognized as the first to study heterostyly in primroses and as the one who provided the functional significance of the two types of flowers.<sup>1</sup>

Species expressing heterostyly often have so-called plate-like flowers, whose lower part is tubular in shape. The stamens are fused with the flower tube. In the *L*-phenotype, this leads to pollen compartments in the flower tube being fixed in a low position. In the *K*-phenotype flowers, the pollen compartments are positioned much higher, towards the opening of the flower tube.<sup>2,3</sup> It is easy to imagine the purpose of this arrangement: flower-visiting insects transport the pollen from the short stamens to flowers with short pistils, and vice versa, due to the places where the respective pollen sticks to an insect’s body. It is a very clever design to promote and maintain sexual reproduction. Yet, the genetics of the situation are complex and surprising. The history of how we figured out the biology and genetics of heterostyly is also very interesting.

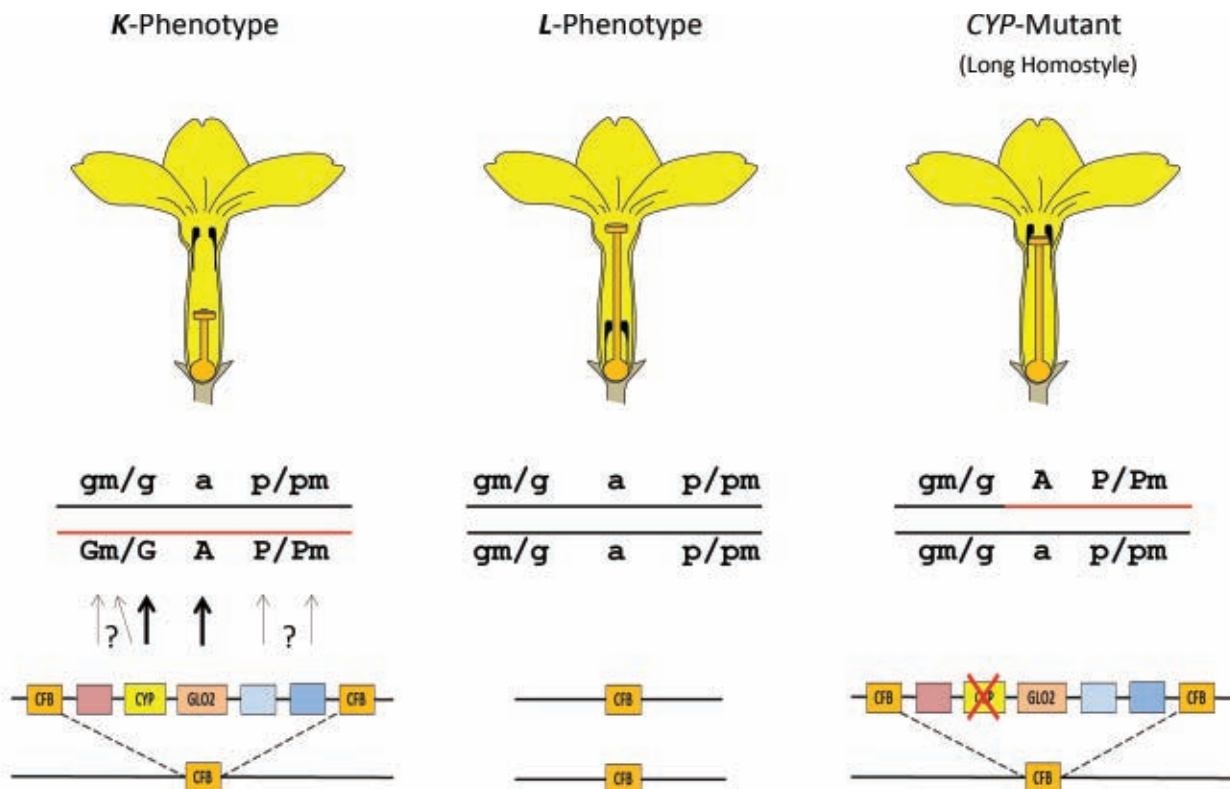
## Genetics of heterostyly

Most experimental crosses with primroses suggested that the traits of the *L*- and *K*-flowers were inherited as if it were due to a single allele pair (*S* and *s*). The site is now called the *S*-locus (a ‘locus’ is a specific site on a chromosome). Primroses of the *K*-phenotype are therefore *S/S* homozygotes and *S/s* heterozygotes, while those of the *L*-phenotype can be understood as *s/s* homozygotes. Nevertheless, so-called homostyle flowers in which the style and the stamens are on the same level also exist (figure 1). These flowers show that

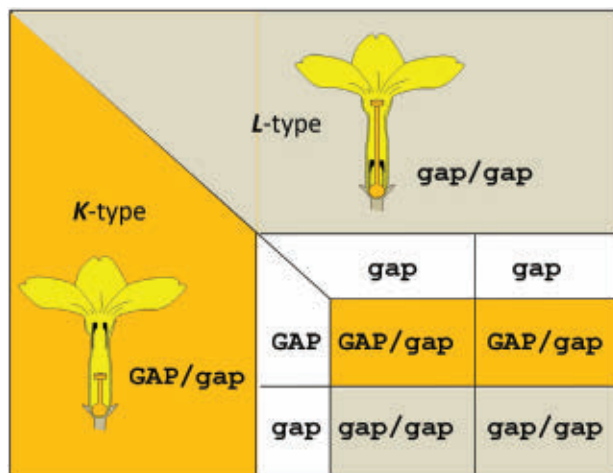
the characteristics are determined by at least two separate but closely linked genes.<sup>4</sup> This was known for quite some time, but then some very rare and unusual flower types were found, some of which had long stamens and small pollen grains, others short stamens and large pollen grains. They proved that pollen size can be inherited independently and so an extra gene had to be postulated. The new types of flowers had to be caused by new alleles in the *S*-locus, which led to the conclusion that it represents at least three very closely linked genes, which determine the different characteristics of heterostyly.<sup>5</sup>

Note that thus far in the discussion, a ‘gene’ is being defined as ‘an inheritable unit’. All this work was done before we knew what the units of inheritance were (i.e. stretches of DNA). Thus, at first, we knew that two flower types existed, so this was put down as the result of two different forms of the same ‘gene’. We then realized that additional flower types also existed, so the first ‘gene’ had to be subdivided into several more. Following Mendelian genetics, these genes should have dominant and recessive alleles. In this view, the first gene (with alleles *G* and *g*) would determine the length

of the style and papillae, the second gene (with alleles *A* and *a*) would determine the length of the stamens, while the third gene (with alleles *P* and *p*) would determine pollen size and thus male compatibility. Since all three genes are usually associated with each other, the *L*-phenotype thus has the genotype *GAP/gap* and the *K*-phenotype *gpa/gpa*. Crosses between *GAP/gap* and *gap/gap* plants always produce *K* and *L* phenotypes in a 1:1 ratio (figure 2), which corresponds to observations in nature. This view prevailed until the 1990s. Why *GAP/GAP* did not exist in nature was unknown. The extremely rare homostyle flowers were thought to be due to a recombination event of the chromosomes, in which the genes are exchanged, and in this way the atypical combination formed. It was also suspected that two other genes should exist responsible for female and male incompatibility, since it would be unlikely that a single gene could control both morphological and incompatibility aspects of the flowers.<sup>6</sup> Thus, the *S*-locus appeared to be a so-called *supergene*, a chromosomal segment with several tightly linked individual genes that together control an integrated phenotype comprised of several traits.



**Figure 1.** Genetics of heterostyly. Top: Schematic diagram of the *K*-phenotype (left) and the *L*-phenotype (middle). There is a spatial correspondence between the *K*-type style and the *L*-type anthers, and between the *L*-type style and the *K*-type anthers. Middle: The classic genetic model for the *S*-locus with two alleles containing five genes: *G* for style length, *Gm* for female incompatibility, *A* for position of stamens, *P* for pollen size and *Pm* for male incompatibility. Dominant alleles are identified by capital letters, recessive alleles by lower case letters. Bottom: Schematic representation of the molecular genetic structure of the *S*-locus, in which genes are shown as boxes. The dominant *K*-phenotype has the complete *S*-locus with five genes (left), whereas the recessive *L*-phenotype is characterized by a complete absence of the *S*-locus (middle). Rare homostyle flowers can result from mutations in the *S*-locus genes (right). Loss-of-function mutations of the *CYP* gene have been associated with long homostyle flowers (adapted from reference 4).



**Figure 2.** Schematic presentation of the presumed classical Mendelian inheritance-model of homostyly. Sexual reproduction between the heterozygous *K*-phenotype (alleles 'GAP' and 'gap') and the homozygous *L*-phenotype (alleles 'gap' and 'gap') always produce *K*- and *L*-phenotypes in a 1:1 ratio. That there is no physical 'gap' allele has only recently been discovered.

Supergenes are always inherited as a single group and stand as an excellent genetic design principle, which enables programmed adaptations that can be released in only one or a few steps. Recently, supergenes have been found to control mimicry in butterflies and sexual dimorphism in ruffs (the bird *Philomachus pugnax*), as well as adaptations in honeybees and zebrafish.<sup>7</sup> In primroses, the supergene may not only explain heterostyly, but also the occurrence of very rare homostyle flowers and pollen incompatibility. The identity and function of the genes present in the *S*-locus has only recently been unravelled, as well as a—rather surprising—explanation for the dominant and recessive alleles.

### Molecular genetic analysis of the *S*-locus

In the 20<sup>th</sup> century, genetic studies on primroses made it possible to create a genetic map of the *S*-locus. Furthermore, sequencing the genome of *Primula veris* (the cowslip, or cowslip primrose) led to a reference genome sequence from a pool of *L*- and *K*-phenotypes. Subsequent transcriptome analyses identified the genes that were most strongly expressed in both flower types.<sup>8,9</sup> These studies formed the basis for two important breakthroughs in our understanding of heterostyly in primroses: the identification and functional description of the complete *S*-locus in the *L*- and *K*-phenotypes.<sup>10,11</sup> They showed that the *S*-locus is located right next to the centromere of the largest chromosome, which would explain why hardly any recombination occurs in the *S*-locus. When geneticists speak of recombination, they mean the exchange of alleles present on homologous chromosome arms (figure 3). If a gene is located near the centromere,

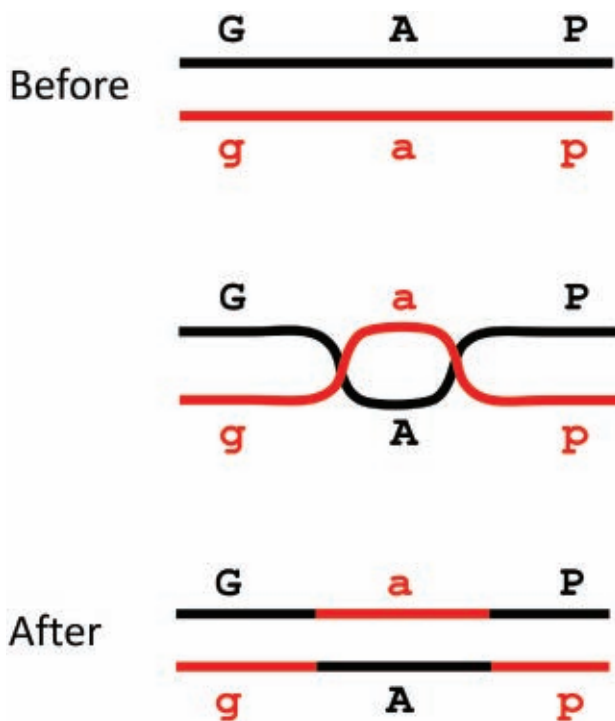
recombination hardly occurs, and genetic exchange is rare. As a result, the inheritance of the entire complex of traits behaves like a single Mendelian locus (as if it were only one trait) and this situation results in the *L*- and *K*-phenotypes remaining in approximately equal amounts.

Only recently have genes been identified that orchestrate heterostyly. In 2016, it was reported that the flowers of the *K*-phenotype express several unique genes, which were absent in the *L*-phenotype.<sup>9</sup> As expected, genes for style length, stamen length, and pollen size were found in the dominant *S*-locus, as well as genes for female and male incompatibility. Of the five genes identified, two had been known previously: *CYP734A50* and *GLO2*. The *CYP734A50* gene codes for a cytochrome P450 enzyme that inactivates a class of cell growth hormones (the so-called 'brassinosteroids'), which makes it understandable that a mutated *CYP734A50* gene is associated with long homostyle flowers. The *GLO2* gene belongs to a family of morphogenetic genes that control and regulate genetic programs that determine the plant's shape and size. Indeed, an inactive *GLO2* gene had been associated with short stamens. So, the *CYP734A50* gene determines the style length and possibly the female incompatibility, whereas the *GLO2* gene is responsible for the length of the stamens.<sup>6</sup> Hence, these two genes form the basis for the *G/g* and *A/a* alleles of classical genetics. The remaining three genes code for a Kelch-repeat F Box protein (KFB), a pumilio-like RNA-binding protein (PUM) and for a protein with a highly conserved C-terminal domain (CCM). It is not yet fully understood how these genes are related to phenotype, although KFB and PUM proteins seem to be responsible for pollen size and male incompatibility.<sup>6</sup> In addition, a so-called *CFB* gene was found flanking both sides of the dominant *S*-locus (see figure 2). The most fascinating observation was, however, that the recessive *s*-locus was about 280,000 DNA letters shorter than the dominant *S*-locus. The *s*-locus contained only a single *CFB* gene and there was no trace of the other genes.<sup>6</sup> The *S*-locus in primroses is therefore hemizygous, i.e. a unique DNA region that occurs only once (mono-allelic) per genome. This finding provides an elegant explanation for the suppressed recombination found in earlier studies, since there simply is no corresponding counterpart for the exchange of genes in the *s*-locus. These recessive traits are not caused by genes, but by the absence of genes!

### The hemizygosity hypothesis

Previously, the term 'baranome' was introduced to describe the genetics of the created kinds.<sup>12</sup> This concept was introduced because the term 'genome', as it is commonly used in genetics, is not sufficient to describe the genetics of created kinds. To explain the rapid diversification of life after the Flood, biblical creation requires created kinds to





**Figure 3.** This simplified scheme shows the presumed double crossover between two chromosomes, which produced the rare homostyle phenotype. That there is no physical ‘gap’ allele was discovered only recently. Instead of such a crossover, homostyle flowers are caused by loss-of-function mutations (see figure 1).

be geared with pluripotent, undifferentiated, and uncommitted genetic information carriers with an intrinsic ability for rapid adaptation and speciation. Thus, created kinds must have cryptic genetic information contained within them. They must have been hardwired with programs to bring forth novel species (after their kind) and mechanisms to induce variation and adaptations. Over the past two decades several of these programs have been discovered: epigenetics<sup>13</sup> and transposable and transposed elements (TEs).<sup>14,15</sup> In addition, there are several ways to program extra information or variation into the chromosomes of a created kind. As argued by Carter, most of the common allelic variation we observe in humans today may have been ‘created diversity’ and would have been present on the original chromosomes in Eden.<sup>16</sup> This suggests that other created kinds contained many heterozygous genes (‘alleles’). Furthermore, it has been argued that baranomes may have been preloaded with mechanisms designed for the rapid induction and/or release of cryptic information by TEs.<sup>14,15</sup> It should be noted that in the creation paradigm TEs could be renamed ‘variation-inducing genetic elements’ (VIGEs).<sup>17</sup> There may be more characteristics of modern genomes that indicate what baranomes may have originally looked like. The hemizygous *S*-locus with five unique genes in primroses provides an additional paradigm

for preloaded cryptic genetic information. Created kinds may have contained many features that were originally hemizygous, which could easily become fixed or lost through population dynamics (i.e. selection, genetic drift, etc.). With preloaded hemizygous genetic information, adaptation and formation of new species does not necessarily require millions of years. It may, in fact, occur in the blink of an eye. Due to population dynamics and VIGE activity, preloaded hemizygous information may also rapidly disappear from differentiating baranomes/genomes.

### Hemizygous variation within species is huge

Until recently, it was tacitly assumed that all individuals within a single species should contain approximately the same number of genes. This assumption, however, has proven to be wrong. Recent molecular genetics demonstrated that the genomes of organisms belonging to the same species are so variable that geneticists today rather assume that there is no such thing as ‘a species genome’. For example, in the wild forms of the mouse-ear cress (*Arabidopsis thaliana*), approximately 4% of the genes are completely different from the reference genome or are not found at all.<sup>18</sup> Something very similar can be observed in the *K*- and *L*-phenotypes of primroses. A comparison of the genomes of the two phenotypes would show that at least five genes are missing in the *L*-plants: *GLO2*, *CYP734A50*, *KFB*, *PUM*, and *CCM*. The strict separation of these hemizygous genes on different chromosomes is best interpreted as evidence of programmed variation, especially since there is no plausible evolutionary explanation for the existence and multiple independent occurrence of these genes: heterostyly has emerged independently at least 20 times in different 28 plant families.<sup>2</sup> Even within families, such as the *Boraginaceae* (forget-me-nots and borage), several independent origins have been reported.<sup>19</sup> Rather than independent acquisition, the *Boraginaceae* may have repeatedly lost the genes responsible for heterostyly, so that the trait was maintained in a hemizygous way in several members of this family and lost in others. Moreover, in the six genera studied so far, heterostyly also appears to be controlled by a single locus that is very similar to the supergene of primroses.<sup>20</sup> Explained away as ‘convergent evolution’ by our Darwinian friends,<sup>21</sup> an intelligent design signal could not be stronger.

The *Human Genome Project* and the *1,000 Genomes Project* lend credence to the ‘hemizygosity hypothesis’. Structural variations—such as insertions and deletions, but also inversions and translocations—are very important genetic variants, but until recently our techniques to identify them lagged behind those developed to identify single nucleotide polymorphisms (SNPs). The human reference genome was initially built with approximately 2/3 of the data coming from

one single individual genome and on false ideas that human genetic diversity was rather limited. As more genomes were sequenced, it became more obvious that individual genomes are much more variable than originally anticipated. The sequencing and *de novo* assembly of a Korean individual filled more than 100 gaps in the reference genome.<sup>22</sup> Since 360 megabases (12%) of the genomes of 270 individuals with ancestry in Europe, Africa, and Asia differ due to indels (insertions and deletions, which may be part of created diversity or due to *de novo* mutation), every individual has a unique pattern of gains and losses of complete sections of DNA.<sup>23</sup> Imagine what happens if a Korean and an African individual would marry and produce offspring. Indeed, a significant part (several percent) of the DNA sequences of the genomes of the children might come in a hemizygous state! Numerous child-rich marriages between individuals of different human populations are evidence that hemizygous

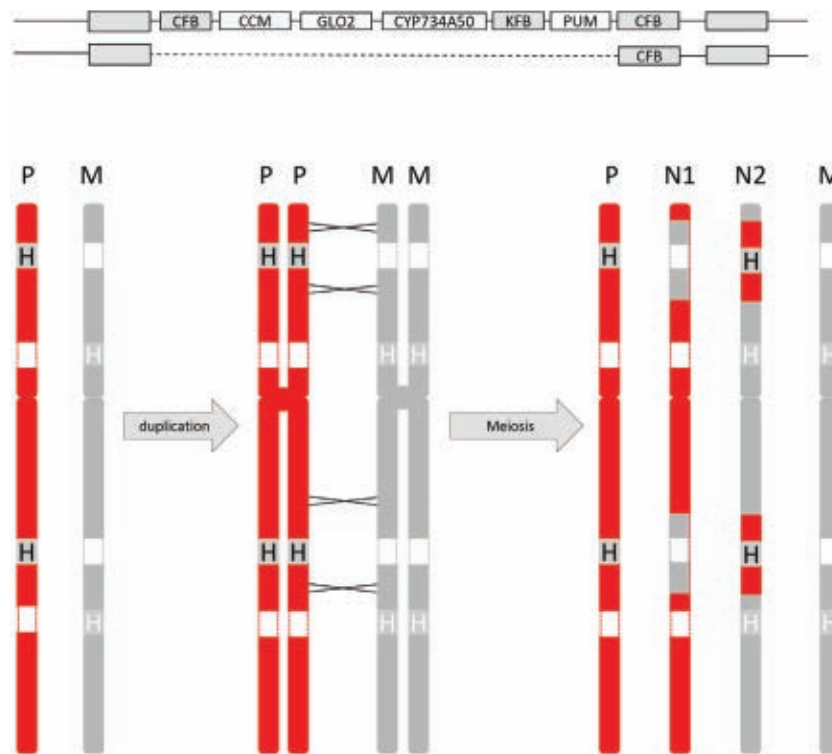
genomes easily match and lead to fertile offspring. This shows that hemizygosity does not interfere with reproductive success.

The hemizygosity hypothesis may also explain why we find a high number of indel-differences in different *Homo* subspecies (i.e. Neandertal, Denisovan, and modern man). In 2011, 584 human-specific conserved indels (short: hCONDEL) were found and examined in more detail. These sequences with a median size of 2,804 bp are found in chimpanzees but seem to be completely missing in the human genome. They are found almost exclusively in non-coding regions, often in the vicinity of genes involved in steroid hormone signal transduction and neuronal function, where they can serve as regulatory elements for gene expression. They are claimed to be tissue-specific enhancers that may underlie the regulatory changes necessary for the evolutionary divergence of humans and chimpanzees.<sup>24</sup> Interestingly, about half

of these hCONDELs were detected in archaic humans (Neandertals and Denisovans), indicating that they have disappeared from the genome of modern humans.<sup>25</sup> Mendelian genetics and genetic drift are able to readily reduce hemizygosity to homozygosity in small and isolated populations. Therefore, hemizygosity may explain why we observe DNA sequences in Neandertals that are completely missing from the modern human genomes. It should be noted that sequences present hemizygously in our human ancestors did not only provide instant dominant/recessive trait pairs; they could also be readily lost when such traits were not subject to strong selection. The disappearance of hemizygous regions from the genome is not very hard to conceive since all studied genomes contain elaborate genetic engineering mechanisms in the form of VIGEs. VIGEs have the ability to restructure and recombine the genetic material instantly.<sup>12,13,26</sup> Their omnipresence in the genome makes them excellent tools to understand the indel-mutations observed in the human subpopulations.<sup>23</sup>

## Conclusion

It is essential to have a working creation science model that systematically and reliably explains variation, adaptation, and speciation in a biblical



**Figure 4.** Top: In the diploid genome of the primrose, only one chromosome contains the genetic information for the genes *CCM*, *GLO2*, *CYP734A50*, *PUM*, and *KFB*. The other chromosome lacks these genes completely. The genetic term for this observation is hemizygosity. Bottom: For fertile offspring sister-chromosomes do not have to be completely identical, meaning that they do not have to contain the exact same genes and haploid gametes can form normally during meiosis. The letter H indicates hemizygous regions present in homologous chromosomes. In a similar way, an unanticipated abundance of genetic information might have been preloaded in the baranomes of the created species. The 1,000 Genomes Project showed that 12% of the genomes of subpopulations of humans may differ due to indel-mutations. Crossing between subpopulations of humans must therefore lead to offspring carrying a substantial part of their genes in a hemizygous way. Due to crossovers 'novel' chromosomes are readily produced during meioses. Abbreviations: P = paternal chromosome; M = Maternal chromosome; N1 and N2 = 'novel' chromosomes; and H = hemizygous region.

timescale. Many incisive researchers who take the Bible seriously have been working on such models for decades.

These efforts have met with limited success, mainly because the genetic basis for created kinds has long been elusive. Although preloaded genetic evolution models have been put forward for long timeframes,<sup>27</sup> it is only recently that we begin to understand how it might work for short timeframes. In the 21<sup>st</sup> century we have come to understand the genome as a highly dynamic information storage and processing device that is prepared to adapt to changing environments. Organisms do not necessarily have to wait for random mutations to adapt and speciate, since their genomes contain preloaded programs and mechanisms that respond to all sorts of unexpected challenges. These super-sophisticated genomes have all the hallmarks of intelligent design and this is exactly what we would expect from a biblical perspective.

In this paper, a novel mechanism for rapid baranomic diversification was introduced and discussed using the hemizygoty concept of heterostyly in primroses. In diploid genomes, significantly more information can be stored than previously thought possible if some of that information is stored hemizygotously. Due to genetic recombination and Mendel's laws of heredity, the unique hemizygous information can then simply be spread across different populations (figure 4). Isn't there grandeur to this view of life, where God chose to create life as adaptive, free-living entities equipped with pluripotent baranomes, so that the earth could bring forth living creatures—livestock and creeping things and the beasts of the earth—according to their kinds?

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# The volcanism and age of Io

Wayne Spencer

Jupiter's moon, Io, is by far the most active volcanic body in our solar system. Io raises questions regarding what drives its intense volcanism. Scientists have endeavoured to explain the heat radiated by Io and its interesting surface features. Theoretical models of Io have been developed that imply Io has been recycled by volcanism and tectonics over billions of years. However, it is possible to reinterpret the evidence from Io from a young age perspective.

The age of Io was addressed in my 2003 paper in *Proceedings of the Fifth International Conference on Creationism*.<sup>1</sup> That paper described tidal dissipation and the active volcanism in this moon of Jupiter. It was argued that an age of less than 10,000 years for Io was more plausible than an age of billions of years. Tidal dissipation is a well-known process generating heat in the interior of Io as it orbits Jupiter. The heat is generated from distortion of the shape of the body, more specifically from friction and movement of non-rigid material in the interior. Io radiates approximately  $10^{14}$  watts of energy in infrared radiation.<sup>2,3</sup> In the 2003 paper, I argued that tidal dissipation was not the only heat source in Io and that if Io is understood as only thousands of years old, some of the heat could still be primordial. This paper will update the subject of Io and its volcanism and argue that a young age is still plausible in the light of recent research.

Io is highly influenced by its relative nearness to Jupiter. To compare it to our moon, Io is 6 Jupiter radii from the planet, but our moon is 60 Earth radii from its planet. This, along with the rapid rotation of Jupiter, combines to make the tidal forces on Io very strong. The tidal forces, the orbital motion, and the volcanism on Io are all interacting processes. Io is in a three-body orbital resonance with Europa and Ganymede. This resonance puts the orbital periods of Io, Europa, and Ganymede in a ratio of 1:2:4, where Io is the nearest of the Galilean moons to Jupiter, with Europa and then Ganymede farther out. This resonance causes some periodic variations in Io's orbit but the tidal effects in Io, Europa, and Ganymede tend to resist the orbital variations and generate internal friction. Scientists have often assumed that Io would migrate outward from Jupiter over time due to the tidal forces, but observations have never really confirmed this.<sup>4</sup> Astrometric measurements of Io have not yielded consistent results as to whether Io moves inward toward Jupiter or outward away from Jupiter.

The volcanism in Io is understood as being caused by tidal dissipation heating. Because tidal dissipation is a known, ongoing process, it appears to support the old-age view. In 2003,<sup>1</sup> I argued that tidal dissipation is not the only heat source. In 2003, models of Io were falling short by about one order of magnitude from the  $10^{14}$  W energy output above. I

proposed there was primordial heat from creation dissipating in Io in addition to heat from the tidal forces. This paper will re-examine this and other issues about Io.

The age of Io should be considered in relation to the long-term viability of the models of Io's interior and its volcanism. In my paper,<sup>1</sup> a model of the interior of Io was described by Spohn.<sup>5</sup> Spohn's model proposed that large molten magma chambers would build up in Io's mantle. These magma chambers would drive the volcanism observed on Io's surface. In models of Io from the early 1990s and prior to 2000, the mantle of Io was assumed to be partially molten, but there was no discussion of liquid layers or 'magma oceans' in Io or other moons of the outer solar system. Today, liquid, or partially liquid, layers have been proposed by researchers, to explain Io as well as other moons.<sup>6,7</sup> Models of the core of Io were clarified by data from the *Galileo* mission, which began collecting data about Jupiter and Io from 1995 until the fall of 2003. Gravity measurements from the *Galileo* spacecraft established that Io does have a metallic core.<sup>8</sup> There has long been a consensus among planetary scientists that the core of Io is likely to be a mixture of iron and iron sulfide, which is approximately 850–900 km in diameter (about 50% the total diameter of Io).<sup>9</sup> The information we have on Io is data acquired from orbit or from Earth observations. Much of the orbital data comes from the *Galileo* mission. The *Juno* spacecraft is currently orbiting Jupiter and is doing new infrared measurements of Io, though Io is not the focus of the *Juno* mission.

## Io volcanism

The *Voyager 1* mission photographed erupting volcanic plumes from Io in 1979. The *Galileo* mission was much better suited than that of *Voyager 1* to study the temperature and composition of surface processes related to volcanism. Io's volcanism is varied in nature. The surface of Io is predominately yellow to red in colour from sulfur materials. The red material is hotter. There is significant white sulfur dioxide as well as elemental sulfur and sulfur chain molecules on the surface. The sulfur changes colour as it cools. However, Io's overall density is close to that of our moon. Evidence

of silicate lavas and ultramafic lavas were found on the surface by *Galileo* from detection of materials on the surface over 1,000 K in temperature. The hottest molten materials on the surface are the ultramafic lavas (likely containing magnesium), which have been measured to have temperatures reaching 1,870 K.<sup>10</sup> The sulfur seems to be driven out as the hotter lavas reach the surface. Liquid lava flows occur on Io as well as some pyroclastic eruptions. The hot basalt and other hot lavas are black unless they are hot enough to glow. Io's surface appearance was observed to change from comparing the *Voyager* images to *Galileo* images and even in comparing images from one *Galileo* orbit to another. Some volcanic hotspots were discovered from Earth observations after the *Galileo* mission, and one new hotspot was discovered near the Io South Pole by the *Juno* spacecraft.<sup>11</sup>

The black eruption sites on the surface are referred to as paterae on Io. Paterae can be described as caldera-like depressions that have been centres of volcanic eruptions. It has been estimated that about 20% of the paterae observed during the *Galileo* mission were active during the periods of observation.<sup>12</sup> This and photos of the surface suggest there are fault structures that seem to affect where the eruptions take place. Some volcanic sites erupt frequently, while other sites of large eruptions are less frequent. The Loki site (12° N, 310° W) erupts once or twice per year, but it is responsible for about 25% of the heat given off by Io. It is thought to be a large lava lake that covers over, erupting periodically. However, Loki does not have some of the hottest lavas that are present at many other sites. There are also very dramatic eruptions occasionally, usually referred to as 'outbursts', that can potentially double the entire heat output of Io for a period of weeks.

The first evidences of volcanism on Io were the volcanic plumes seen by the *Voyager* spacecraft. *Galileo* also observed eruption plumes, of differing types. Plume eruptions are

always found to be from volcanic sites near Io's equator. One large volcano on Io with eruption plumes is Pele. The Pele site (22° S, 283° W) plumes contain a mix of sulfur molecules and silicate pyroclastic material. These plumes have reached heights over 300 km above Io's surface. The heat from Pele is nearly a constant  $240 \pm 40$  GW, yet little lava is seen (figure 1). This suggests the lava is hidden under the surface.<sup>3</sup> There are several lava eruption sites on Io that can produce large volumes of lava. The largest eruption of lava in volume observed by the *Galileo* spacecraft was at the Pillan site, between 7 May and 18 June 1997. Davies, 2001, describes this eruption, comparing it with a notable Earth eruption of 1783 in Iceland:

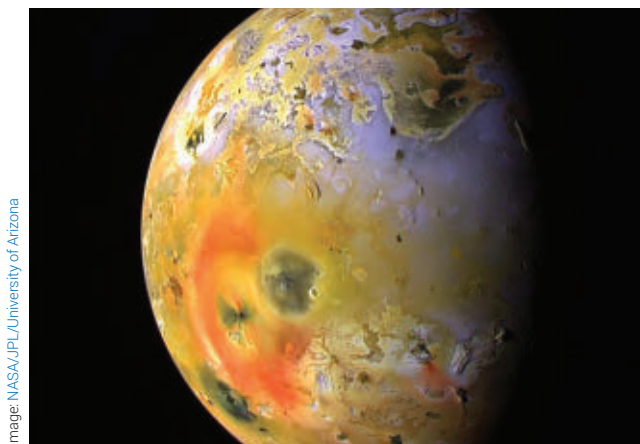
"In the space of a few months, over 5,300 km<sup>2</sup> of Io's surface was covered with lava to a depth of about 10 m ... an eruption volume of 53 km<sup>3</sup>. The largest terrestrial eruption ever witnessed (in terms of the eruption volume flux) was Laki in 1783 (Thordarson and Self, 1993), which emplaced 15 km<sup>3</sup> of lava in a few months."<sup>13</sup>

### Io research today

Since the *Galileo* mission to Jupiter, much analysis of Io has been done by researchers. The total heat power radiated by Io (as infrared) is still taken as  $10^{14}$  W from Io research. Expressed as heat power output per unit surface area, Io's surface gives off an average of 2.24 W/m<sup>2</sup>.<sup>12,14</sup> This value is roughly 20 times the surface heat flux for the Earth. Today much more is known about the distribution of mountains, hot spots, and lava on Io's surface. The term 'hotspot' for Io refers to the outlet region where a volcanic eruption takes place. This can be related to a volcanic plume or the eruption of molten rock or both.

The *Galileo* spacecraft measured the magnetic field in the vicinity of Jupiter. Analysis of this magnetic data led to two conclusions: 1) that Io does not have a significant magnetic field of its own, and 2) that there is evidence Jupiter's magnetic field is inducing a magnetic field in molten material under Io's surface.<sup>16</sup> Scientists modelled the interior of Io in various ways to find what combination of internal layers and mineral properties would fit the *Galileo* magnetic measurements best. The magnetic field was found to vary in a manner that correlated with Io's motion, thus implying an induced field in Io. Researchers Khurana *et al.*<sup>15</sup> concluded that the Io interior model which fit observations best treats Io as having an asthenosphere with a global layer of partially molten material at least 50 km thick and which is at least 20% molten. This has been sometimes referred to as Io's 'liquid layer', or as a 'magma ocean'. But in describing it as liquid this does not mean it is completely molten; it would only be partially molten.

How much can we trust these conclusions regarding the magnetic measurements implying there is a 'molten layer'



**Figure 1.** Io's varied surface colours and other features from a *Galileo* mission image taken in 1997. The Pele volcano is circled in red. The black and grey dark mound to the right of it is Pillan Patera. White material is sulfur dioxide; materials yellow to brown to red are various forms of sulfur.

on Io? First, the general magnetic theory behind this measurement technique is sound, and it has been used in analysis of Earth rocks as well as rocks from our moon. At Jupiter, the technique has been used to study all four of the Galilean moons: Io, Europa, Ganymede, and Callisto.<sup>16</sup> The *Galileo* spacecraft made a total of 35 orbits of Jupiter during its mission, but only a few of these orbits were useful for attempting to measure an induced field for Io. In some cases, it flew by Io closer to the poles, which is not conducive to measuring an induced field. In the 2011 paper by Khurana *et al.*, which argues for a global magma ocean in Io's interior, the authors point out that only four orbits, referred to as I24, I27, I31, and I32, were useful for studying magnetic induction.<sup>15</sup> Of these four, detailed plots and discussion is only provided in the paper for the first two of these flybys, I24 and I27. These were cases where the spacecraft passed near to the equator of Io. These researchers compared different models of Io's interior and plotted the induced magnetic field compared to measurements from the spacecraft. The two most successful models were a hot, solid mantle at 1,400 °C and an asthenosphere model with a 20% melt fraction overlying a hot solid mantle. For the I27 orbit case, both models were reasonably good fits to the data. For the I24 orbit case, the asthenosphere with 20% melt was a better fit than the hot, solid mantle model.

An induced magnetic field will show a variation that is periodic with the orbital period and the spin period of the moon. This is the case at Io, but the analysis assumes a global 'molten' layer and compares the theoretical induced field to the measurements. Flybys have a weakness in that they may not be able to represent both time and space variations in the field realistically. Good magnetic data of this kind requires many orbits and sensitive instruments in the spacecraft. Thus, it seems questionable to conclude there is a global melt layer based only on one flyby (I24). On the other hand, there must be significant material under Io's surface conducting an induced current. It seems the data on Io point to a significant amount of molten material under the surface of Io, but whether it is concentrated into one partially molten layer or is distributed in some other way in a solid matrix is not clear.

The picture from researchers emerging today for the interior of Io is that Io has a mantle that is largely solid near the core but contains more melt closer to the top of the mantle. Planetary scientists tend to at least tentatively accept that there is a molten or partly molten asthenosphere layer under the Ionian crust and above the mantle. Estimates of the thickness of the crust range from 11 to 90 km.<sup>17</sup> The Io lithosphere is understood to be largely cold and quite solid, except near possible lava 'pipes' and faults bringing hot material toward the surface. (Note that the term 'lithosphere' refers to something of multiple possible layers, that could include the crust, which reaches the surface.) The lithosphere must be solid because Io does have mountains that are up to 17 km in height. The lithosphere must be able

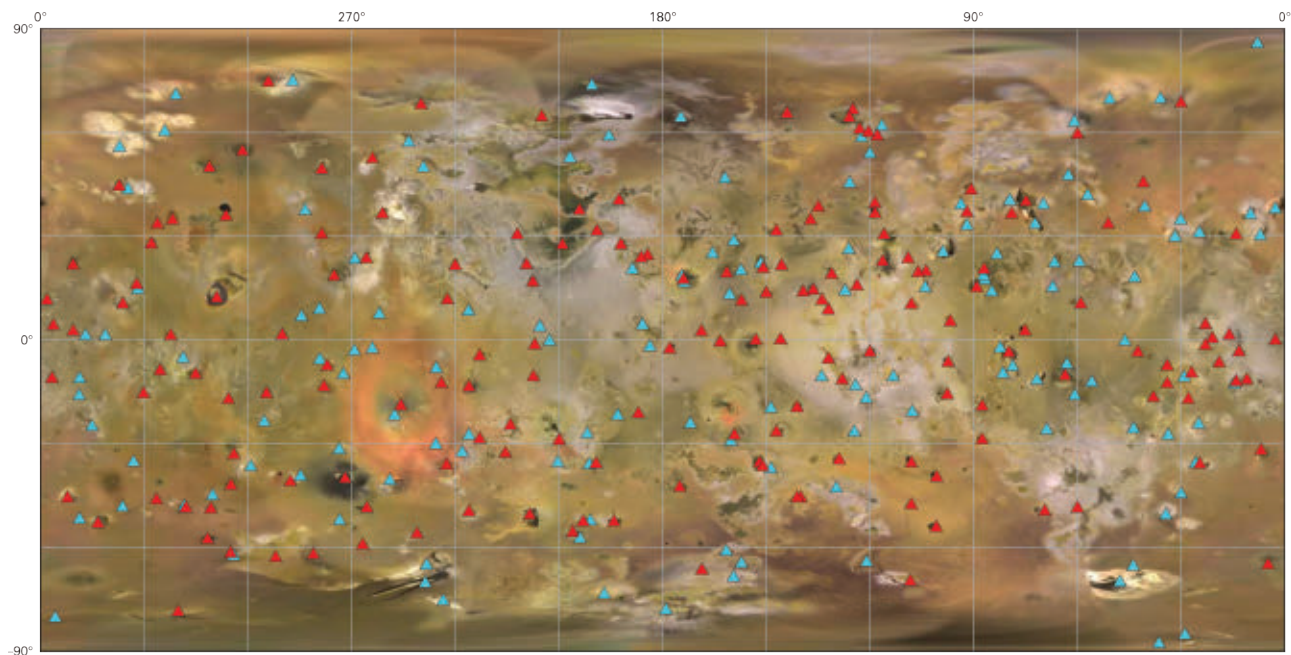
to support the mountains. The molten layer below the lithosphere is thought to be 50 km thick (or more). Magma is thought to rise through the mantle and through the molten layer. Cooling lava tends to be buried by sulfur compounds on the surface. The large amount of lava weighs down the surface and is thought to force material into the melt layer over time. Then, below the melt layer it is assumed there is mantle convection, which brings hot mantle material up to the melt layer. Thus, the melt layer is thought to mix material from the surface and from the mantle. Mantle convection then would carry material from the molten layer down into the mantle again. In this way, it is thought that much of the mass of Io's mantle, asthenosphere, and crust could be recycled over long periods of time. There is no evidence of a plate-tectonics-type process on Io, thus the above process has been described as a 'vertical tectonics'.

Io research has directed much attention to studying the surface features. The distribution of volcanic hot spots and the Ionian mountains are significant clues to understanding Io. The *Galileo* mission also allowed some insight into how Io's volcanism changes over time. During and after volcanic eruptions on Io, the appearance of the surface can change over periods of a few hours. Some interesting trends have emerged from correlating Earth-based infrared observations with *Galileo* mission data. First, the distribution of hot spots on Io is usually correlated with the paterae. However, Io's mountains are not well correlated with the hot spots. Thus, Io mountains are not generally volcanic eruption sites. Sometimes there are fault structures in the vicinity of a mountain where there may be paterae near the mountain, but many hot spots and paterae are not near mountains. Another important fact is that the majority of hot spots and paterae sites are in a belt of latitudes approximately 30° north and south of Io's equator. However, there are some notable volcanic sites far North of the equator, such as the Chalybes Regio, which is at 55° north latitude.<sup>14</sup>

Since the volcanism on Io was discovered in the late 1970's, the physics of tidal dissipation has become better understood. The efficiency of a body such as a moon in generating heat from tidal forces depends on the internal structure and material properties in the body. Our moon is much colder and more rigid than Io, and it is also farther from Earth in comparison to the size of Earth. This makes the tidal dissipation heating much less for our moon. The overall density of Io is not too different from our moon, but Io has a much larger core than our moon and has much more heat energy being transported to the surface than has our moon or Earth, for a given amount of surface area.

Two simple models illustrate how different bodies can respond differently to tidal stresses. Tidal forces create a periodic stress and strain on the minerals of the interior of a solid body. If a body consisted of a liquid iron core surrounded by a solid mantle and lithosphere, tidal dissipation would generate the greatest heating near the poles (of the spin





**Figure 2.** Map of the Io surface showing volcanic outlet hotspots (red triangles) and mountains (blue triangles). Longitude angles along the top are measured from East (right edge) to West (left edge). Map excerpted from [USGS Scientific Investigations Map 3168](#), USGS and NASA.

axis). In this first mode, most of the heat would come from solid body tides in the deep interior. On the other hand, if a body had a solid core and mantle with a soft, hot partially molten layer under the crust (as is proposed today for Io), most of the tidal heating manifested at the surface would be in a band surrounding the equator.<sup>18,17</sup> In this second mode, the heat comes more from tidal action on fluids in the asthenosphere region. This comes out of computer simulations of the effects of tidal forces. Io seems to blend these two patterns, but with the second heat distribution (heat in an equatorial band) more predominant.

### Mountains versus hotspots

The important features of Io's surface are mountains, patera, and volcanic hotspots. The hotspots are active sources of volcanic eruptions of sulfur materials and/or silicate lavas. The approximate numbers of these features over the entire photographed surface of Io are as follows.<sup>12,20</sup>

**Table 1.** Approximate count of mountains, paterae, and hotspots on Io

Feature	Number
Mountains	135
Patera	400–500
Hotspots	173

Io patera are similar to volcanic calderas on Earth, but they are not related to mountains in the same manner as on Earth. Alexandra A. Ahern *et al.* describe paterae this way: “Paterae have steep walls and flat floors that are often covered or partially covered by relatively young lava flow deposits . . . . The average patera effective diameter (diameter of a circle having the same area as the patera) from a database of 417 paterae is 41 km.”<sup>20</sup> As we have seen, ‘hotspots’ refers to active volcanic eruption sites where sulfurous and/or silicate lavas erupt. Many, but not all, of the hotspots are located within the patera depressions. There are many paterae that are not active eruption sites. The fact that the volcanic eruption sites are not located on mountains but are sometimes near them has led to much debate over what the relationship is between the paterae and the mountains. Figure 2 shows a United States Geological Survey map of Io, pointing out mapped hotspots and mountains.<sup>20</sup>

Io's mountains are tectonically uplifted structures, often near faults. Io's mountains are rather different from most mountains on Earth. Ahern *et al.* provide a useful description of Io's mountains below. They also point out there is no indication of plate tectonics on Io such as we find on Earth:

“Despite Io's persistent volcanic activity, its ~135 reported mountains (Turtle *et al.*, 2001; Turtle *et al.*, 2007) are, with very few exceptions, classified as tectonic rather than volcanic in origin . . . . They lack distinguishable vents, calderas, or flows emanating from their summits (Turtle *et al.*, 2001) and are blocky and steep-sided, rather than conical. Ionian mountains have been defined by Schenk *et al.* (2001) as features

of positive relief and measurable size higher than 1 km, not solely created by erosional processes. Schenk *et al.* (2001) measured the average mountain height to be 6.3 km, with Io's highest peak, Boösaule Montes, rising to  $17.5 \pm 3$  km above the surface ... There was no pattern or alignment of mountains to suggest that a global tectonic regime, such as terrestrial-style plate tectonics, could be responsible for them."<sup>20</sup>

There is a tendency for both the mountains and hotspots to be somewhat clustered by longitude on Io. If you were to draw a line through the centre of Io toward the centre of Jupiter, the asthenospheric heating model would predict that the greatest heating around the equator would be where this line meets the Io surface on the side near Jupiter ('the sub-Jovian point') and the side opposite Jupiter ('the anti-Jovian point'). This is in fact the case, except the hottest regions are offset eastward somewhat from this line. Mountains, on the other hand, are somewhat clustered in the opposing manner, near the leading and trailing sides of Io, toward and away from its direction of motion in its orbit (see figure 3). Though the relationship between the paterae and the mountains is not well understood, it is clear tidal forces in Io have had a significant effect on the surface structures and the hotspots.

Io's surface is definitely young. No impact craters are visible anywhere on the surface, likely because of the resurfacing. The patera structures themselves would probably have a limited lifetime as well because new eruptions could melt the patera walls, cause them to collapse, or cover them, over time. It has been estimated many structures on the surface of Io would only have a 'lifetime' of approximately 1 million years.<sup>13,10,20</sup> Also, Laszlo Keszthelyi *et al.* estimate the time necessary to form the paterae structures, "Since most paterae are hundreds of meters to a few kilometers deep, this suggests that patera formation typically takes on the order of  $10^2$ – $10^5$  years."<sup>10</sup>

### Heat distribution

Scientists have considered the problem of what mechanism could transfer adequate heat to the surface. To address this, a concept was proposed in 1981 that scientists seem to still follow variations on today.<sup>22</sup> This proposed there were volcanic vents or dikes that transported lava vertically through a thick Io lithosphere, and below the lithosphere was a partially molten mantle. This is much like today's approach, but the *Galileo* magnetic measurements suggested a melt layer below the lithosphere containing more melt than the mantle below it. The large volumes of lava that spread out over the surface are understood to force material down into the mantle over time. The exact nature of Io's mantle is still debated.

Of Io's 173 active hotspots that have been mapped, above, 92 lie in the band of latitudes from 30° south to 30° north. These are the most frequent and persistent eruption sites.

Those north of 30° N latitude were 38 and those south of 30° S latitude were 43. Thus, there are a significant number of hotspots that are not in the equatorial band of latitudes. In addition, Io has occasional large volcanic events that are short-lived (the outbursts).

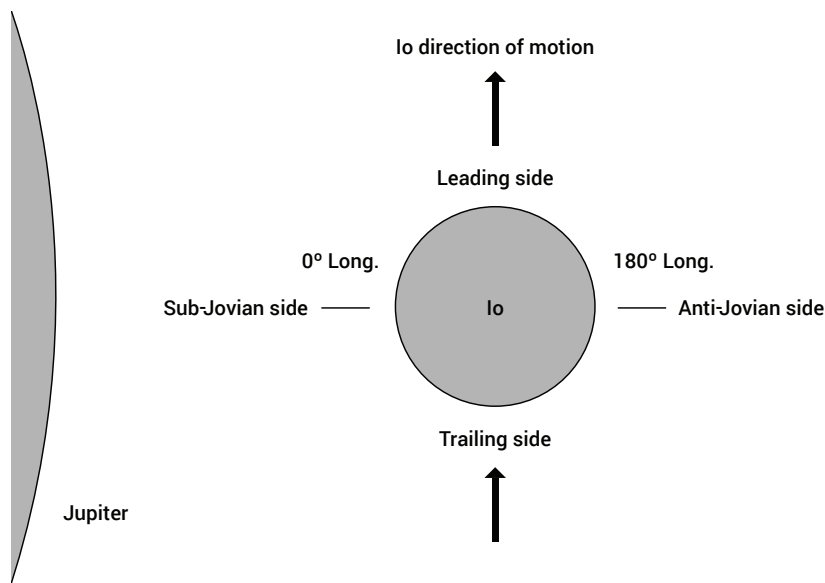
Cantrall *et al.*, 2018, summarized geologic associations of surface features and volcanic activity from 2001 to 2016.<sup>14</sup> This study brought together data from both Earth telescope infrared observations and the *Galileo* mission. Cantrall *et al.* state, "Volcanic outbursts on Io represent the most powerful eruptions in the Solar System."<sup>14</sup> This same study indicated that over both the *Galileo* mission years and the 15 years of Earth observations, Io's global heat flux was largely constant, overall. These researchers comment on the source of the magma driving Io's volcanism:

"While our observations show the greatest heat flux from low to mid-latitudes, they also suggest a significant magma source feeding higher latitude regions. ... Together, these observations indicate that heat dissipation is also occurring at depths beyond the asthenosphere and more likely in the mantle."<sup>14</sup>

A.G. Davies *et al.* analyzed *Galileo* mission results and found that the heat from Io's hot spot volcanic centres accounts for about 54% of the total output of Io as determined from Earth ground-based thermal infrared measurements.<sup>3</sup> This raises the obvious question concerning the other 46%. Davies *et al.* argue it is coming from the Io poles. They point out evidence for this from the *Galileo* photopolarimeter radiometer (PPR). This instrument looks at the degree of polarization of reflected light and measured the intensity of infrared radiation from Io:

"Galileo PPR data revealed that Io has anomalously warm surfaces at high latitudes (Rathbun *et al.*, 2004), showing that nighttime brightness temperatures at latitudes between 60° S and 75° S ranged from ~95 K to ~90 K. This temperature is higher than the expected 80 K to less than 70 K."<sup>3</sup>

A.G. Davies *et al.* argue that if the 90 to 95 K temperatures covered the northern and southern portions of the surface from about 43° or 48° north latitude up (and similarly in the south) then this could account for the 46% of Io's heat output.<sup>3</sup> They go on to say, "If all of the unaccounted for energy is being lost from Io's poles, then this would imply a ratio of shallow (asthenospheric) to deep (mantle) heating of about 1:1."<sup>3</sup> This shows the heat output on Io's surface is not only following the asthenospheric models with heat from the equatorial band, but heat is also coming from the polar regions. In Io, the lower mantle seems to be more rigid and has less molten material than the upper mantle. This would make the tidal dissipation mechanism less efficient in the lower mantle in generating heat, based on theoretical models. Thus, scientists have found it somewhat surprising that Io has hotspots nearer to the poles. The deep mantle heat may also be from tidal dissipation, or some of it may be



**Figure 3.** Diagram viewing Io as if above its orbit around Jupiter. The sub-Jovian and anti-Jovian points are expected to be the points of greatest tidal heating if the heat comes primarily from a partially molten layer below Io's lithosphere.

heat from creation. The upper mantle heat source has likely developed in its current configuration due to ongoing tidal forces and volcanism.

In Spencer, 2003, it was argued that observations of infrared emissions from Io were about one order of magnitude larger than what could be explained from tidal dissipation heating. However, the issue of whether the models have been able to match the observed radiated heat output of Io is still debated among researchers today. In Valery Lainey *et al.*, from 2009, it was argued that their tidal model for the heat output matched well with the observations from the orbit astrometric measurements.<sup>23</sup> This study is the most recent astrometric orbit analysis of Io. However, the methods in this study are out of date. First, they did not use *Galileo* mission data due to a problem in *Galileo*'s high-gain antenna. They also neglected the tidal dissipation in Europa and Ganymede. Also, some of the assumptions in their analysis are considered inaccurate today, such as that the tidal dissipation Quality Factor (Q) of Jupiter is a constant.

In an important research report from 2019 (of which Valery Lainey was a coauthor), Katherine de Kleer *et al.* comment on the Lainey 2019 results.<sup>24</sup> They point out that if the tidal dissipation of Europa and Ganymede are included, the tidal heat figure becomes  $0.5 \times 10^{14}$  W, which is less than the observed value. More recent studies (such as Beuthe<sup>18</sup> and Tyler<sup>19</sup>) attempt to better account for the internal properties of the body. Tyler *et al.* indicated they could match the surface heat flux of  $2.25 \text{ W/m}^2$  under certain conditions.<sup>18</sup> Today's tidal models fit observations better than those of 2003, but there is still debate as to whether theoretical tidal dissipation calculations can adequately match the observed heat output.<sup>3</sup>

Yet for considering the age of Io, there may be a more important issue. Are today's models of Io plausible over billions of years?

### Io over billions of years

In today's models of Io, the moon must recycle itself. This means that Io must have been completely resurfaced many times in the history of the solar system, including a process of destroying and rebuilding the mountains. Keszthelyi *et al.* aptly summarize the magnitude of the problem. These comments were made not long after the end of the *Galileo* mission:

"If Io has been as volcanically active as it is today (erupting  $\sim 550 \text{ km}^3/\text{yr.}$  of lava (Blaney *et al.*, 1995) for the past 4 billion years, it has produced a volume of lava equivalent to  $\sim 140$  times

the volume of Io. ... The observed enstatite-rich, high-melting-temperature lavas should not exist on a highly differentiated Io. The only way such lavas could exist is to efficiently recycle the crust into the mantle."<sup>10</sup>

This figure of 140 times the volume of Io presents a problem for assuming Io is very old. In recycling a moon, likely the core would not participate since it is not feasible to 'remix' the core with mantle material. *Galileo* gravity measurements estimated that Io's core accounted for about 14% of the mass of Io.<sup>9</sup> Thus, leaving the core mass out of the recycling could increase the 140 figure above to 160 times the portion of Io participating in the recycling. Also, the quote above comments on high-melting-temperature lavas. One would expect that after many cycles of remixing into the mantle and volcanism driving material back to the surface, the higher-density minerals would stay in the lower mantle and the composition of the lavas reaching the surface should become more uniform over time. Yet the spectra and temperatures observed on the surface imply the lavas are of varied compositions.

This recycling of Io's entire mass 140 times in over 4 billion years appears to be taken on faith by scientists today. The possibility of Io being only several thousand years old is not considered in the above comments. Yet, assuming a young age simplifies explaining Io. On evaluation, recycling the entire surface of Io would require a process to destroy and rebuild the mountains many times! There is no seismic data from Io to verify any of the subsurface structure that models have proposed. The volume of lavas on Io is also very nonuniform, being much greater in certain sites in the equatorial regions than in the northern or southern latitudes,



most of the time. This raises the question as to whether a partially molten layer would be stable over long periods of time. Some form of dikes or lava vents bringing the large volumes of lava to the surface is plausible and is somewhat similar to evidence for volcanism on our moon. But currently there is no way to verify if material from the crust is mixing back into the mantle.

A young-age view of Io eliminates the need to explain how a mass equivalent to most of the mass of Io could be recycled many times. In a young-age view, the volcanism could be essentially one way. There is some evidence suggesting large magma chambers under Io's surface (such as Loki). Presumably, these do not remix into the mantle because they are not dense enough to sink. There is not a clear explanation of how the remixing into the mantle would take place. Only the assumption that the weight of the lavas would accomplish it.

### Conclusions

Though research on Io has progressed since 2003, a young-age view is still plausible and indeed less problematic. Today, I would consider a global partially molten layer under the lithosphere to be plausible, but not necessarily the only possible configuration for the molten material. But the distribution of molten material under the surface of Io is not critical to the question of the age of Io. The recycling of material through volcanism and mixing with the mantle is more the real problem. Io does have lithospheric blocks or what one could call 'plates' (which support the mountains) but there is no evidence of plate tectonics. Though Io's most active volcanic sites are generally within a band near the Io equator, there are also volcanic sites at high latitudes. Tidal dissipation heating appears to be at work both in the deep mantle of Io and in the upper mantle.

Today, scientists have been able to construct theoretical interior models that produce at least close to the observed heat output. But even with this apparent success, the implications of the models require a process that would recycle the volume of Io 140 times in over 4.5 billion years. All the mountains on Io would have to have been broken up and recycled into the mantle, then rebuilt repeatedly. There is evidence of some uplift of mountains along fault structures. The large volume of lavas likely creates stresses that cause some isostatic readjustment of the surface. But to infer from this that the entire moon has been recycled over and over is unreasonable. It is clear that the surface of Io is relatively young. Thus, the entire moon can be interpreted as young without contradicting known facts. Io is unique among moons in our solar system. It provides a useful laboratory for the study of tidal effects and orbit resonance. Io was apparently created to be a volcanic powerhouse which demonstrates God's creativity.

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# Critical analysis of Humphreys' shell metric cosmology

Phillip W. Dennis

It is shown herein that the Humphreys' solution for the metric inside a thin shell of matter is incorrect. The interior metric is independent of time and there is no 'timeless' zone in the interior. The interior of the shell is flat and isometric to Minkowski spacetime. We expect this as the interior of the shell has no gravitational field, as in the Newtonian limit. It is also shown herein that Humphreys' assertion of new solutions of the Einstein field equations (EFE) is incorrect. The metrics he presents do not solve the EFE. In fact, one form of the solution is obtained by a major mathematical error. Thus, the conclusion herein is that the shell model is fatally flawed and does not provide a solution to the starlight travel time problem.

In papers<sup>1,2</sup> published in the *Journal of Creation*, Russ Humphreys makes several extraordinary claims about a new solution to the EFE of conventional general relativity (GR). One such claim is the existence of 'timeless' zones.<sup>2</sup> It is the purpose of this paper to show that, contra Humphreys, spacetime in the interior of the shell is flat and *static* and is isomorphic to a subset of Minkowski space. As a result, clocks inside the shell are inertial and measure proper time. Pulsations in the radius of the shell as a function of time have no local effect on clocks in the interior. We expect this from the equivalence principle and the Newtonian limit of GR. In GR the idea of a constant gravitational 'potential' function inside of the shell is not relevant and can lead to mistaken conclusions. This is the case in the manner in which Humphreys imposed continuity on the metric and then induced a time-dependent 'potential' inside of  $R(t)$ . Humphreys provides no justification of his continuity requirement, other than a suggestive appeal to a putative Newtonian gravitational potential. Regarding these two claims, we show that continuity of metric components is not a requirement for connected manifolds. Moreover, extreme time dilation is a relativistic effect and is the regime in which Newtonian physics is completely inapplicable. As this note will show, Humphreys' requirement is at odds with the formalism of GR and also ignores the fact that the Newtonian potential, which is illegitimately imported into GR, is only defined up to an arbitrary constant. Humphreys' conclusions of 'stopped clocks' and 'timeless zones' in the interior are mistaken.<sup>2</sup> His new arguments repeat the same mistaken interpretation of the time coordinate as is evident in his original ideas, published in *Starlight and Time*.<sup>3</sup> In the course of this paper, two solutions for an inhomogeneous solution with an interior cavity are presented. Both solutions show there is no 'timeless zone' in the cavity.

Also, it is shown below that Humphreys' assertion of new solutions of the EFE is incorrect. The metrics he asserts

do not solve the EFE. In fact, one form of the solution is obtained by what I will demonstrate to be a major mathematical error.

This error appears to be instrumental in reinforcing Humphreys' notion that his new 'principles' of metric continuity and Newtonian potentials in GR are correct.

Finally, it should be noted, the shell configuration that Humphreys proposes was correctly solved by W. Israel.<sup>6</sup> That solution appears as exercises 21.25–27 in MTW.<sup>7</sup> The solution to that exercise shows that Humphreys' position is incorrect. While the solution could be presented, it is felt that the following critique would be more accessible to readers without extensive knowledge of differential geometry techniques. Those who have such knowledge are referred to Israel<sup>6</sup> and MTW.

Notation conventions are  $c = 1$ , and  $d\Omega^2 = (d\theta^2 + \sin^2 \theta d\phi^2)$

## Derivation of the interior and exterior metric of a thin shell within GR

Contra Humphreys,<sup>1</sup> the interior of the spherical shell is static and flat (isometric to Minkowski space). I follow Synge.<sup>8</sup> In this section I derive the correct metric of a shell by staying within the theory of GR. I point out later that Humphreys' condition overlooks the fact that Newtonian potentials are only defined up to an arbitrary reference value.

With a slight change in notation we write the metric as (cf. Synge (1971), p. 270):

$$ds^2 = -e^\gamma dt^2 + e^\alpha dr^2 + r^2 (d\theta^2 + \sin^2 \theta d\phi^2) \quad (1)$$

The functions  $\alpha$  and  $\gamma$  are functions of the coordinates  $r = x^1$  and  $t = x^4$ . The pertinent Einstein equations reduce to (cf. Eq. 81, p. 282 in Synge):

$$\begin{aligned}
G_1^1 &= r^{-2} - r^{-2}e^{-\alpha}(1+r\gamma_1) \\
G_2^2 = G_3^3 &= e^{-\alpha} \left( -\frac{1}{2}\gamma_{11} - \frac{1}{4}\gamma_1^2 - \frac{1}{2}r^{-1}\gamma_1 + \frac{1}{2}r^{-1}\alpha_1 + \frac{1}{4}\alpha_1\gamma_1 \right) \\
&\quad + e^{-\gamma} \left( \frac{1}{2}\alpha_{44} + \frac{1}{4}\alpha_4^2 - \frac{1}{4}\alpha_4\gamma_4 \right) \\
G_4^4 &= r^{-2} - r^{-2}e^{-\alpha}(1-r\alpha_1) \\
e^\alpha G_4^1 &= -e^\gamma G_1^4 = -r^{-1}\alpha_4
\end{aligned} \tag{2}$$

$G_b^a$  are the components of the Einstein tensor, subscripts on  $\alpha, \gamma$  denote partial derivatives with respect to the coordinates  $r = x^1$  and  $t = x^4$ .

The third equation in (2) can be integrated in terms of  $G$  which is directly related to the stress-energy tensor. Cf. equation (83) p. 273 in Synge:

$$e^{-\sigma} = 1 + \frac{8\pi}{r} \int_0^r r'^2 T_4^4 dr' + \frac{C(t)}{r} \tag{3}$$

In eq.(3) we have substituted  $G_4^4 = -8\pi T_4^4$  and included the term which depends on the time dependent ‘constant’ of integration,  $C(t)$ . Note that  $C(t)=0$ , since otherwise the metric is singular at the origin, which would be unphysical as there is no matter at the origin.

We now integrate the equation along a  $t=\text{constant}$  surface, using a stress-energy for a shell instantaneously at  $r=R(t)$ , for which:

$$T_4^4 = -\frac{M\delta(r-R)}{4\pi r^2} \tag{4}$$

(Note  $\delta(x)$  is the Dirac delta function.) This yields the result:

$$e^{-\sigma} = \begin{cases} 1 & \text{if } r < R(t) \\ 1 - \frac{2M}{r} & \text{if } r \geq R(t) \end{cases} \tag{5}$$

We now use this to integrate the first ( $G_1^1$ ) of the equations (cf. equation (84) in Synge (1971))

$$\begin{aligned}
\gamma &= \int_0^r \left( \frac{e^\sigma - 1}{r} - re^\sigma G_1^1 \right) dr \\
&= \int_0^r \left( \frac{e^\sigma - 1}{r} + 8\pi re^\sigma T_1^1 \right) dr
\end{aligned} \tag{6}$$

For the interior where  $r < R(t)$ , with  $T_1^1=0$ , yields

$$\gamma = \gamma(0) = 0. \tag{7}$$

The choice of  $\gamma(0) = 0$  is due to the stipulation (boundary condition) that the  $t$  coordinate is the time measured by

a clock at rest at the origin  $r=0$ . Such a clock is inertial and will register the proper time  $dt = \sqrt{-ds^2}$ . Comparing this with equation (1) requires  $\gamma = 0$  or  $g_{44} = -1$  for  $r < R(t)$ .

Rather than setting up a stress energy tensor for the shell at this point, in order to integrate beyond  $r = R(t)$ , we note that by Birkhoff’s theorem the solution exterior to the mass shell is the Schwarzschild solution. Therefore,

$$\begin{aligned}
ds^2 &= -dT^2 + dr^2 + r^2 d\Omega^2 & \text{if } r < R(\tau) \\
ds^2 &= -\left(1 - \frac{2M}{r}\right) dt^2 + \left(1 - \frac{2M}{r}\right)^{-1} dr^2 + r^2 d\Omega^2 & \text{if } r > R(\tau)
\end{aligned} \tag{8}$$

Equations (5) and (8) show that the interior solution is flat, static Minkowski space (empty space with no gravitational effects) and that the metric local coordinate components are *discontinuous*. This is the same solution as given by W. Israel.<sup>6</sup> Note that  $T$  is the physical (proper) time of inertial clocks in the cavity; and  $t$  is the physical (proper) time of inertial clocks at ‘infinity’. In particular  $T \neq t$  and equation (8) shows the two charts that cover different regions of the solution. Appendix A below provides the embedding equations that demonstrate the consistency of the solution. This solution is what we would expect from first principles of GR and the Newtonian limit as the spherical shell can have no physical effect on the interior (there is no gravitational field in the interior). From equation (5), above, the metric is not continuous but has a step discontinuity at the shell. This is expected from first principles. This shows that Humphreys’ *ad hoc* requirement of a ‘continuous Newtonian potential’ boundary condition for the metric is mistaken. *It is a misapplication of Newtonian concepts in a general relativistic domain where they do not apply.*<sup>9</sup> We revisit the continuity requirement in section 10, below; again, showing that the requirement is false.

In closing, we see that this result could be obtained directly from Birkhoff’s theorem. The interior spherically symmetric solution must be static, and since there is no central mass, simply setting  $M = 0$  in the Schwarzschild solution yields Minkowski space in the interior. Also, we can simplify issues of the stress-energy tensor by solving the EFE in comoving coordinates. We do this below, from which we will again see that the interior is flat Minkowski space. The main point of this section was to derive the discontinuity of the metric components and to establish that the interior is Minkowski from a simple integration of the EFE.<sup>10</sup>

### Claim of an exact solution is false

Humphreys<sup>1,2</sup> claims that his metric is an exact solution of the EFE. That claim was not shown rigorously and Humphreys just seems to have thought it was a solution since  $\Phi$  was assumed to be constant. It is trivially so if  $\Phi$  is a constant independent of both position and time. Then in an unproven



generalization, he makes  $R$  a function of time, which violates the assumed constancy.  $\Phi$  then becomes a function of time. I write his metric here:

$$ds^2 = -(1+2\Phi(t))dt^2 + (1+2\Phi(t))^{-1}(dx^2 + dy^2 + dz^2) \quad (9)$$

Using Synge's space-like sign convention rather than Humphreys' time-like sign convention for ease of analysis (the sign convention does not alter the physics), rewriting in polar coordinates gives:

$$ds^2 = -(1+2\Phi(t))dt^2 + (1+2\Phi(t))^{-1}[dr^2 + r^2(d\theta^2 + \sin^2\theta d\varphi^2)] \quad (10)$$

In this form we can immediately employ Synge's equations for the EFE in *isotropic coordinates* and compute the mixed Einstein tensor. The Synge metric, equation (70) p. 270, is:

$$ds^2 = -e^\alpha dt^2 + e^\alpha dr^2 + e^\beta (d\theta^2 + \sin^2\theta d\varphi^2) \quad (11)$$

Comparing (10) with (11), respectively, we get the identifications:

$$\begin{aligned} e^\alpha &= (1+2\Phi)^{-1} \\ e^\beta &= r^2 e^\alpha = r^2 (1+2\Phi)^{-1} \\ e^\gamma &= (1+2\Phi) \\ \alpha &= -\log(1+2\Phi) \\ \beta &= \alpha + 2\log r = 2\log r - \log(1+2\Phi) \\ \gamma &= \log(1+2\Phi) \end{aligned} \quad (12)$$

Next, we evaluate the partial derivatives needed for the mixed Einstein tensor (Synge (1971), equation (78), p. 272). This gives the following non-zero factors:

$$\begin{aligned} \alpha_1 &= 0 \\ \alpha_4 &= -2\Phi(1+2\Phi)^{-1} \\ \beta_1 &= \frac{2}{r} \\ \beta_4 &= \alpha_4 = -2\Phi(1+2\Phi)^{-1} \\ \gamma_4 &= 2\Phi(1+2\Phi)^{-1} \end{aligned} \quad (14)$$

The needed second derivatives are:

$$\begin{aligned} \alpha_{44} &= -2\ddot{\Phi}(1+2\Phi)^{-1} + 4\dot{\Phi}^2(1+2\Phi)^{-2} \\ \beta_{11} &= -\frac{2}{r^2} \\ \beta_{44} &= \alpha_{44} \end{aligned} \quad (15)$$

To show that the metric is not a solution, we need only show that one component of the Einstein tensor is not zero. The energy component  $G_4^4$  is easiest and will suffice. Using

the third equation of the equations (78) in Synge (1971) gives:

$$\begin{aligned} G_4^4 &= e^{-\alpha} \left( -\beta_{11} - \frac{3}{4}\beta_1^2 + \frac{1}{2}\alpha_1\beta_1 \right) + e^{-\beta} + e^{-\gamma} \left( \frac{1}{4}\beta_4^2 + \frac{1}{2}\alpha_4\beta_4 \right) \\ &= (1+2\Phi) \left( \frac{2}{r^2} - \frac{3}{4} \left( \frac{2}{r} \right)^2 \right) + \frac{1}{r^2} (1+2\Phi) \\ &\quad + (1+2\Phi)^{-1} \left[ \frac{1}{4} \left( \frac{-2\dot{\Phi}}{(1+2\Phi)} \right)^2 + \frac{1}{2} \left( \frac{-2\dot{\Phi}}{(1+2\Phi)} \right) \left( \frac{-2\dot{\Phi}}{(1+2\Phi)} \right) \right] \end{aligned} \quad (16)$$

The first two terms cancel. Simplifying the third term gives:

$$G_4^4 = \frac{3\dot{\Phi}^2}{(1+2\Phi)^3} \quad (17)$$

This should be zero as it is proportional to the energy density and there is no energy density inside the shell. This is only zero if  $\Phi$  is *not a function of time*. Hence, Humphreys' assertion that the metric (9) is exact does not hold up. We note that this proof is in addition to the proof in equation (3) of section 2, which also showed that the metric inside the shell could not be *time dependent*.

Appendix B displays the entire Einstein tensor for both forms of Humphreys' interior metric. From those, we can detect the other unsupportable claim regarding the interior stress tensor, which will be discussed below.

### The correct isotropic form of the spherically symmetric solution

In the previous section, we took a look at the Humphreys' claimed solution. It will be noted that his solution is in the *isotropic coordinate system*, where the form of the metric interval is:

$$ds^2 = -F(t,r)dt^2 + G(t,r)(dx^2 + dy^2 + dz^2) \quad (18)$$

However, the correct isotropic solution, as found in many texts,<sup>11</sup> is:

$$\begin{aligned} ds^2 &= -\left[ (1-\phi/2)/(1+\phi/2) \right]^2 dt^2 + (1+\phi/2)^4 (dx^2 + dy^2 + dz^2) \\ \phi(r) &= M/r \end{aligned} \quad (19)$$

This solution, in terms of a 'potential', is clearly not the solution claimed by Humphreys shown in eq. (9) above.

### A major mathematical error

Humphreys comes to his conclusion partly due to a major mathematical error. The error occurs in equation (A44), where Humphreys claims "a simple transformation of the radial coordinate, ... will eliminate  $f(t)$  from eq. (A43)". However, eq. (A44) is not a proper coordinate transformation.

Coordinate differentials (properly 1-forms on a manifold) must be exact. Humphreys writes, in eq. (A44):

$$d\bar{r}^2 = e^{f(t)} dr^2 \quad (20)$$

Or

$$d\bar{r}^2 = e^{f(t)/2} dr \quad (21)$$

showing that  $d\bar{r}$  is not an exact differential. The correct way to perform coordinate transforms is to specify the new coordinates as functions of the old coordinates. This is an elemental principle of tensor calculus. Let  $y^a$  be the new coordinates and  $x^b$  the old coordinates. The correct transformation is to write:

$$y^a = \varphi^a(x) \quad (22)$$

The differentials then transform like contravariant vectors.

$$dy^a = \frac{\partial \varphi^a}{\partial x^b} dx^b \quad (23)$$

Since  $\bar{r}$  is intended to be a function of  $t$  and  $r$ , it is correctly specified via:

$$\bar{r} = \varphi(t, r) \quad (24)$$

We then get the exact differential:

$$d\bar{r} = (\partial \varphi / \partial t) dt + (\partial \varphi / \partial r) dr \quad (25)$$

Not,  $d\bar{r} = e^{f(t)/2} dr$  as in eq. (21).

This mathematical error and disregard for basic principles of tensor calculus is the precursor to Humphreys' final erroneous isotropic form of the metric in eq. (A59) and the conclusions drawn from it.

### Misapplication of the Newtonian potential

We have shown, by way of several methods, that Humphreys' equations are not a solution of the EFE. As mentioned in section 1, Humphreys' claimed solution is based upon an illegitimate importing of a Newtonian potential into the metric tensor and an illegitimate imposition of a continuity condition. However, it is well known that potentials are only defined up to an arbitrary constant. The potential represents the work required to move an object against the force to which the potential is related. This is expressed in introductory physics texts as:

$$W = \int_A^B \vec{F} \cdot d\vec{r}$$

When the force is conservative, such as the gravitational field, the work is independent of path and the work can be used to define a potential that is a single valued function of position. Work is then measured by the *change* in potential.

$$\Delta U = U(\vec{x}_B) - U(\vec{x}_A) = -W = -\int_A^B \vec{F} \cdot d\vec{r} \quad (26)$$

This shows that the potential is defined relative to an *arbitrary* reference point (A) and an *arbitrary* value of the

potential at that point. Due to the conservative nature of the force, the force is related to the potential via:

$$\vec{F} = -\nabla U$$

This also underscores the fact that adding an arbitrary constant to  $U$  has no physical consequences. The same gravitational field is represented. Choosing  $r = \text{infinity}$  and a value of zero for the potential there is arbitrary and merely a convention. *Changing the value of the reference potential by convention cannot cause changes in physical time dilation.*<sup>12</sup>

Instead of using infinity as the reference point and reference potential, one could choose the origin as the reference point and the reference potential. Using a reference potential of zero at the origin, equation (26) gives:

$$\frac{U}{m} = \Phi(r) = \begin{cases} 0 & \text{if } r < r_0 \\ GM \left( \frac{1}{r_0} - \frac{1}{r} \right) & \text{if } r \geq r_0 \end{cases}$$

This potential yields the same *Newtonian physics* as choosing infinity as the reference. However, if one were to use this potential in the metric tensor one would obtain an entirely different physical 'effect'. In this case, clocks in the interior tick normally, while clocks at infinity tick more rapidly as the shell radius decreases. Neither of these two cases is true—they were both obtained by a faulty analogy. We also note that based on Humphreys' claims clocks can be made to tick slower or faster by way of an *action-at-a-distance* potential, i.e. superluminal. Rather than an improper mixing of non-relativistic Newtonian gravity with relativistic concepts, the correct result is obtained from properly using the GR formalism, resulting in equation (8) above.

All of the above are refutations of the main foundational claims of Humphreys' papers.<sup>1,2</sup> If they are invalid, the rest of the essay needs no more refutation. However, we now address a continuing theme in Humphreys' misunderstanding of the mathematical foundations of general relativity.

### Which way to the future?

Humphreys continues to make the error regarding which coordinates represent time. This is apparent when he talks about 'imaginary times' and 'timeless zones' (or 'achronicity').

In the following, the space-like signature convention is used:  $(-, +, +, +)$ . Angle brackets denote the invariant metric of the space-time. Consequently, a vector  $u$  pointing in the time direction would satisfy the invariant equation:

$$\langle u, u \rangle < 0$$

Now let us consider a world line in Schwarzschild space-time that is moving in the ' $t$ ' direction of the Schwarzschild

coordinates. Such a world line, in a general coordinate chart (not the Schwarzschild coordinates) labeled  $y^a$ , is given in terms of parametric equation:

$$y^a = y^a(t)$$

The vector tangent to this curve is:

$$u = u^a \frac{\partial}{\partial y^a} = \frac{\partial y^a}{\partial t} \frac{\partial}{\partial y^a}$$

Evaluation of the invariant norm gives:

$$\begin{aligned} \langle u, u \rangle &= \left\langle u^a \frac{\partial}{\partial y^a}, u^b \frac{\partial}{\partial y^b} \right\rangle \\ &= \left\langle \frac{\partial}{\partial y^a}, \frac{\partial}{\partial y^b} \right\rangle \frac{\partial y^a}{\partial t} \frac{\partial y^b}{\partial t} \\ &= g_{ab} \frac{\partial y^a}{\partial t} \frac{\partial y^b}{\partial t} \end{aligned}$$

The last step used the definition of the metric components as inner products of the basis vectors in  $y$  coordinates. The last expression is the invariant norm in the coordinates given by  $y$ ; which is precisely the transformation equation for the  $g_{tt}$  component of the metric in Schwarzschild coordinates. Thus:

$$\langle u, u \rangle = g_{tt}^{\text{Schwarzschild}} = - \left( 1 - \frac{2M}{r} \right) \quad (27)$$

Equation (27) is all that is needed. If  $r > 2M$ , then we see that inner product is less than zero and hence  $u$  is time-like in the exterior region outside the event horizon. However, if  $r < 2M$  (i.e. events inside the event horizon), then the inner product is positive. Thus, inside the event horizon  $u$  is space-like, and moving in the direction labelled by  $t$  is not a motion in time.

These considerations also highlight the fact that once the shell crosses the coordinate singularity at the horizon, the equation for a material shell of matter of spatial radius  $r$  is no longer specifiable using the delta function given in equation (4) above.

At this point we also note that Humphreys' claim of a 'timeless' zone based on the metric in equation (9), above, is not only incorrect because of equation (27), but also because the other three dimensions ( $dx, dy, dz$ ) become *temporal* due to the change in sign for  $r < 2M$ . The end result is that Humphreys' model would be spatially one dimensional and temporally three dimensional in the interior. Clearly, that does not qualify as a 'timeless' zone. The misinterpretation is again based on what seems to be a myopic fixation on the metric coefficient of the  $t$  coordinate and a seeming lack of rigorous geometric analysis. Of course, we repeat that equation (9) is not a solution of the field equations and so these conclusions are also based on an erroneous geometry.

### A cavity solution in comoving coordinates

As was shown in Dennis,<sup>5</sup> spherically symmetric inhomogeneous models can be constructed in comoving coordinates. A good reference for this analysis is the seminal paper by H. Bondi.<sup>4</sup>

For the case of the cavity, we take the density  $\rho(t, r)$  at some epoch denoted by proper comoving 'cosmic' time  $t=0$  to be given by:

$$\rho(0, r) = \begin{cases} 0 & \text{if } r \leq r_0 \\ \rho_0 & \text{if } r > r_0 \end{cases} \quad (28)$$

Here,  $\rho_0$  is constant. In comoving coordinates the metric is:

$$ds^2 = -dt^2 + g_{rr}(t, r) dr^2 + R^2(t, r) d\Omega^2 \quad (29)$$

The coefficient of  $dt^2$  is  $-1$  since all clocks are radially free-falling at constant comoving coordinate  $r$  and thus register 'cosmic' time  $dt^2 = -ds^2$ . Note that  $R(t, r)$  is no longer a radial coordinate but a function of the comoving coordinate  $r$  and the proper time  $t$ . However, the area of a sphere at time  $t$  and radius  $r$  is still  $4\pi R^2(t, r)$ .

Using eqns. (4)–(6) of Dennis<sup>5</sup> with  $\dot{R} = \partial R / \partial t$  and  $R' = \partial R / \partial r$  (the Bondi<sup>4</sup> equations with changes of notation):

$$\frac{1}{2} \dot{R}^2 - \frac{M(r)}{R} = E(r) \quad (30)$$

$$g_{rr}(t, r) = \frac{(R')^2}{1 + 2E(r)} \quad (31)$$

$$4\pi\rho(t, r) = \frac{M'(r)}{R'R^2} \quad (32)$$

Setting  $E(r) = 0$  (i.e. we are taking the particles to be 'free'), we obtain:

$$\frac{1}{2} \dot{R}^2 - \frac{M(r)}{R} = 0 \quad (33)$$

$$g_{rr}(t, r) = (R')^2 \quad (34)$$

$$4\pi\rho(t, r) = \frac{M'(r)}{R'R^2} \quad (35)$$

The solution of the first equation for  $R$  is then:

$$\begin{aligned} R(t, r) &= \left[ r^{3/2} + \sqrt{\frac{9M(r)}{2}} t \right]^{2/3} \\ &= r \left[ 1 + \sqrt{\frac{9M(r)}{2r^3}} t \right]^{2/3} \end{aligned} \quad (36)$$

We can integrate eq. (35) to obtain:

$$\begin{aligned} M(r) &= 4\pi \int \rho(t, r) d\left(\frac{1}{3} R^3\right) \\ &= \frac{4\pi}{3} \int \rho(0, r) d(R^3) \end{aligned} \quad (37)$$



Since  $\rho(0, r)$  is piecewise constant we can move it outside the integrand, integrate over each constant region, and obtain:

$$M(r) = \begin{cases} 0 & \text{if } r \leq r_0 \\ \frac{4\pi}{3} \rho_0 (R(0, r)^3 - R(0, r_0)^3) & \text{if } r > r_0 \end{cases} \quad (38)$$

We can choose the definition of the comoving coordinate  $r$  so that:

$$R(0, r) = r,$$

obtaining:

$$M(r) = \begin{cases} 0 & \text{if } r \leq r_0 \\ \frac{4\pi}{3} \rho_0 (r^3 - r_0^3) & \text{if } r > r_0 \end{cases} \quad (39)$$

Note that, due to the cavity, an initially homogeneous density will become inhomogeneous over time. However, due to the nature of comoving coordinates, the mass  $M(r)$  inside of comoving radius  $r$  is independent of time. This can be seen from the fact that no matter crosses the lines  $r = \text{constant}$ . The metric for the expanding matter outside the cavity is:

$$ds^2 = -dt^2 + (R'(t, r))^2 dr^2 + r^2 \left[ 1 + \sqrt{\frac{9M(r)}{2r^3}} t \right]^{4/3} d\Omega^2 \quad (40)$$

Now consider the solution for  $r < r_0$ . There  $M(r) = 0$ , and Eq. (36) becomes:

$$R(t, r) = r \quad (41)$$

So, the metric inside the expanding cavity reduces to:

$$ds^2 = -dt^2 + dr^2 + r^2 d\Omega^2 \quad (42)$$

i.e. static Minkowski space. This, as expected, is the same result as Eq. (5) and Eq. (8).

This solution is Minkowski space inside the cavity. Again, there is no ‘timeless’ zone. Clocks tick normally in the interior.

### Birkhoff’s theorem, exceptional claims and exotic energy

In this section we will analyze another aspect of the derivation of the shell metric presented in Appendix A of Humphreys.<sup>1</sup>

The derivation relies on an exceptional claim regarding the stress-energy and also fails to demonstrate a consistency check on the mathematics. The latter results in a remarkable assertion that there is a loophole in Birkhoff’s theorem.

The exceptional claim regarding the stress energy is that it is of the form:

$$T^u = T^v = T^{\theta\theta} = T^{\phi\phi} = 0 \\ T^r \neq 0$$

In this section, to avoid the possibility of scribal lapses, we use the notation and equations from Appendix A of Humphreys.<sup>1</sup> The needed equations for the following analysis are (equation numbers by Humphreys):

$$G_t^t = -e^{-L} \left( \frac{L'}{r} - \frac{1}{r^2} \right) - \frac{1}{r^2} = -8\pi T_t^t \quad (A21)$$

$$G_r^r = -e^{-L} \left( -\frac{N'}{r} - \frac{1}{r^2} \right) - \frac{1}{r^2} = -8\pi T_r^r \quad (A22)$$

$$G_t^r = -e^{-L} \frac{\dot{L}}{r} = -8\pi T_t^r \quad (A24)$$

$$G_r^t = -e^{-N} \frac{\dot{L}}{r} = -8\pi T_r^t \quad (A25)$$

Eq. (A21) is equivalent to the third equation in eq. (2), above.

Integrating it, we can express  $L$  entirely in terms of  $G_t^t$  as follows:

$$\begin{aligned} G_t^t &= -e^{-L} \left( \frac{L'}{r} - \frac{1}{r^2} \right) - \frac{1}{r^2} \\ &= -r^{-2} \left[ e^{-L} (L' - 1) + 1 \right] \\ &= -r^{-2} \left[ - (re^{-L})' + 1 \right] \end{aligned}$$

Thus:

$$\begin{aligned} -r^2 G_t^t &= - (re^{-L})' + 1 \\ (re^{-L})' &= 1 + r^2 G_t^t \end{aligned}$$

Finally, integrating over  $r$  yields:

$$re^{-L} = r + \int r^2 G_t^t dr + C(t)$$

Thus:

$$e^{-L} = 1 + \frac{1}{r} \int r^2 G_t^t dr + \frac{C(t)}{r}$$

This functional form is not equivalent to Humphreys’ shell metric. In fact, for there to be any resemblance, we would need to set  $C(t)$  equal to zero, since it requires a globally time-dependent metric. Additionally, it requires an infinite singularity at the centre of the cavity. The centre singularity would indicate the presence of a time-dependent point mass at the origin, which *ex hypothesis*, is non-existent. For that reason, we set  $C(t) = 0$ . In addition, since Humphreys’ shell model is static (correctly so) for  $r > R(t)$ ,  $C(t)$  must be set to zero.

Now, to show the inconsistency, we take the partial derivative of eq. (A21-D) with respect to time giving:

$$\begin{aligned} -e^{-L} \dot{L} &= \frac{1}{r} \int r^2 G'_{ij} dr + \frac{\dot{C}(t)}{r} \\ -e^{-L} \frac{\dot{L}}{r} &= \frac{1}{r^2} \int r^2 G'_{ij} dr + \frac{\dot{C}(t)}{r^2} \end{aligned} \quad (\text{A21-D})$$

From eq. (A24), the LHS of the last equation is  $G'_i$  thus we get:

$$G'_i = \frac{1}{r^2} \int r^2 G'_{ij} dr + \frac{\dot{C}(t)}{r^2}$$

By Humphreys' assumptions  $G'_i$  is zero inside the cavity (no mass density), thus:

$$G'_i = \frac{\dot{C}(t)}{r^2} = -8\pi T'_i \quad (\text{A24-D})$$

At this point we note two issues. First, eq. (A21-D) is not equivalent to Humphreys' Newtonian potential metric. Second, since  $C$  is independent of location, eq. (A24-D) represents a continuous flow of momentum *everywhere* with an infinite flux at the centre of the cavity. That is not a physically realizable configuration. At any rate, as noted in section 1, the terms of Humphreys' shell metric require  $C(t)=0$ . Thus, there are no off diagonal terms in the stress tensor.

Referring to Appendix B we see there that  $G'_{rr} = 0$ , so that  $T'_{rr} = 0$ .

In summary, the consistent metric for the shell cosmology is the one presented in eq. (8).

### Claim that continuity of space requires continuity of the metric components

Humphreys<sup>1</sup> makes the following claims:

"All the metric coefficients  $g_{\mu\nu}$  are subject to a boundary condition that is very important to my argument. They must be continuous from just outside the shell all the way through to just inside it. Otherwise, spacetime (hence clocks and rulers) would change abruptly from one point to the next. That would be not only contrary to ordinary experience, but also hard to imagine theoretically in the absence of some extraordinary physical cause for it."

"So, if  $L$  were zero in the cavity,  $g_{rr}$  could not vary with time. That conclusion conflicts with our previous conclusion in eq. (A17). Something must be wrong with the reasoning behind at least one of the two conclusions. Eq. (A17) stems straightforwardly from the continuity of spacetime and seems unassailable."<sup>13</sup>

There are two misconceptions in these quotes. The first is that the local coordinate metric components must be continuous throughout a manifold. In the second quote Humphreys' 'unassailable' argument conflates continuity of a local coordinate representation of a metric with 'continuity of spacetime' (however, note that the proper concept would be the *connectedness* of the spacetime). The former does

not follow from the second. Below, we give an example of a two-dimensional manifold that is connected (but not *smooth*) which has discontinuous metric components. The dangers of not properly analyzing the geometries of manifolds with surface layers (as in the shell model) were pointed out by W. Israel<sup>6</sup> many years ago.<sup>14</sup> In short, Eq. (A17) is incorrect.

The second misconception is Humphreys' overlooking the fact that the shell model does contain "some ... physical cause for it". The model contains a surface layer of mass at  $R(t)$ . This constitutes a Dirac delta contribution to the stress-energy tensor. By the EFE this implies that the Einstein tensor also contains a Dirac delta singularity. The result is that there is a discontinuity across the surface layer. The surface layer accounts for the fact that clocks outside the cavity are in a gravitational field (the Riemann tensor is non-zero outside). There, time dilation, relative to clocks at infinity and inside the cavity, takes place—it is due to the mass of the shell. Inside the cavity the Riemann tensor is zero, all clocks at rest in the interior tick at the same rate—there is no central mass inside the shell to influence clocks and rulers. Thus, there is an abrupt change in the spacetime geometry across the shell.

To demonstrate the independence of metric component continuity and spatial continuity we construct a two-dimensional manifold as in figure 1.

The surface consists of a conical section and a cylindrical section, as shown. The apex angle of the cone is  $\alpha$ . We use cylindrical coordinates for the whole manifold, namely  $z$  and the azimuth angle  $\phi$ . This manifold is everywhere flat except for a conical singularity at  $z = 0$  and along the boundary where the extrinsic curvature is infinite in the  $z$ -direction, due to the discontinuous jump in the surface normal.

The boundary between the two regions occurs at  $z = z_0$ .

The metric interval in the cylindrical region is:

$$ds^2 = dz^2 + R^2 d\phi^2$$

in which,  $R = \tan(\alpha)z_0$ .

In the conical region  $r(z) = \tan(\alpha)z$ . This gives  $dr = \tan(\alpha)dz$ . So, on the cone, we get the induced interval:

$$\begin{aligned} ds^2 &= dz^2 + dr(z)^2 + r^2(z) d\phi^2 \\ &= (1 + \tan^2(\alpha)) dz^2 + \tan^2(\alpha) z^2 d\phi^2 \end{aligned}$$

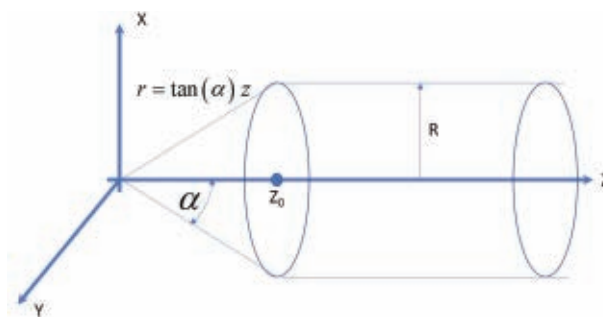


Figure 1. A surface of revolution with discontinuous metric

The complete specification of the metric interval is thus:

$$ds^2 = \begin{cases} (1 + \tan^2(\alpha)) dz^2 + \tan^2(\alpha) z^2 d\phi^2 & \text{if } z \leq z_0 \\ dz^2 + R^2 d\phi^2 & \text{if } z > z_0 \end{cases}$$

It is apparent that the manifold has continuity, yet the component  $g_{zz}$  is discontinuous across the boundary at  $z = z_0$ . As mentioned above there is an extrinsic curvature singularity at the boundary, which occurs at an abrupt change in the geometry.

Such surfaces can be easily multiplied by using the analysis of ‘surfaces of revolution’ covered in calculus.

Let the contour of the surface be specified as:

$$y = f(x)$$

We take  $f$  to be continuous but not necessarily the derivative  $f' = \frac{df}{dx}$ . The equation for the surface is:

$$ds^2 = (1 + f'(x)^2) dx^2 + f(x)^2 d\phi^2$$

Immediately, we see that the metric coefficient  $g_{xx}$  is not continuous if the function  $f$  is only  $C^1$ . We thus see that the ‘unassailable assumption’ of continuity of the metric components to ensure continuity of the manifold is false.

### Conclusion and summary

We have seen the following points regarding Humphreys’ shell-model:

1. The use of a Newtonian potential in GR is illegitimate. It is at odds with the theoretical foundations of GR.
2. The claim that metric components must be continuous is unfounded. We gave examples from GR and from elementary surfaces of revolution that refute Humphreys’ postulated ‘unassailable’ principle.
3. The paper contains fundamental mathematical mistakes. The asserted solution can be shown to be incorrect by substitution into the EFE. Humphreys performs an erroneous ‘coordinate transformation’ to arrive at his putative ‘isotropic solution’. The erroneous transformation contravenes the basics of tensor transformations that are central to GR.
4. There are numerous proofs that the metric inside a spherical cavity surrounded by an arbitrary external spherical distribution of matter is static flat space, i.e. Minkowski space. As a result, there are no timeless zones in the interior. These proofs were: (a) by direct integration of the EFE; (b) by substitution of Humphreys’ metric into the EFE showing that the potential must be time independent inside the cavity; (c) by use of Birkhoff’s theorem; and (d) by solving the EFE in comoving coordinates.

In summary, due to the above, I conclude that the shell-model is fatally flawed at the most fundamental levels of GR due to the paper containing mathematical errors and faulty conceptions.

### Acknowledgements

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9. *The analysis above is sufficient to show that Newtonian potentials are inapplicable to the problem.* However, another point is that the mathematical structure of Newtonian gravity and the theory of general relativity are entirely different. Newtonian gravity is governed by a *time independent* equation for a *scalar* quantity. The gravitational field of GR is governed by *time dependent* equations for a second rank *tensor field*. Algebraically scalars and tensors are entirely different entities. They are not conceptually compatible. For example, the *spin* content (intrinsic angular momentum) of a scalar field is zero while the spin of a symmetric second rank tensor is two. Finally, the ‘critical regions’ (i.e. coordinate singularities) of a putative Newtonian potential are the limits at which *static* configurations cannot be maintained, thus also breaching the conditions for which Newtonian concepts are applicable. *In short, it is fallacious to employ non-relativistic physics to deduce relativistic conclusions. One needs to analyze within the confines of general relativity.*
10. It shouldn’t be necessary to multiply counter examples to Humphreys’ continuity claim, but the infinite discontinuity of  $g_{rr} = \left(1 - \frac{2M}{r}\right)^2$  in the Schwarzschild metric at  $r=2M$  is another exception to the claim.
11. See MTW (1973), Exercise 31.7, p. 840.
12. To make this clear, the *exact general relativistic* formula for time dilation (for clocks at rest relative to the spatial coordinates) is  $ds/d\tau = \sqrt{g_{tt}(1)/g_{tt}(2)} = \sqrt{(1+2\Phi(1))/(1+2\Phi(2))}$ . We have used Humphreys’ substitution in the last equality. This formula shows that one cannot appeal to the Newtonian limit and add a constant  $\Phi_0$  to the potentials since  $\sqrt{(1+2\Phi(1))/(1+2\Phi(2))} \neq \sqrt{(1+2\Phi(1)+2\Phi_0)/(1+2\Phi(2)+2\Phi_0)}$ . Only in the weak field (Newtonian) limit is the last inequality approximately true, yet the argument cannot be substantiated.
13. Humphreys’ equations (A16,17):  $g_r = g_r(r)$ ,  $g_\tau = g_\tau(r)$ , for  $r \leq R(t)$
14. Israel<sup>16</sup> remarks: “In relativity, the ground is more slippery, because smoothness of the gravitational potentials  $g_{\alpha\beta}$  is determined, not only by the smoothness of the physical conditions, but also by the smoothness with which the co-ordinates we happen to be using describe the space-time manifold. We are thus confronted with the not altogether trivial problem of disentangling the bumps arising out of the nature of the physical discontinuity from spurious bumps due to ill-matching of our coordinates at the surface in question.”

### Appendix A—Embedding equations for thin shell solution

We present the embedding equations for the thin-shell solution.

Two regions of space time: (1) Minkowski space in interior of thin spherical shell, denoted  $M_-$ ; (2) Schwarzschild exterior to shell, denoted  $M_+$ . The exterior is the well-known Schwarzschild solution. The interior is Minkowski space.



$$\text{In } M_-: ds^2 = -dT^2 + dr^2 + r^2 d\theta^2 + r^2 \sin^2(\theta) d\varphi^2 \quad \text{A(43)}$$

$$\text{In } M_+: ds^2 = -\left(1 - \frac{2M}{r}\right) dt^2 + \left(1 - \frac{2M}{r}\right)^{-1} dr^2 + r^2 d\theta^2 + r^2 \sin^2(\theta) d\varphi^2 \quad \text{A(44)}$$

$$\text{For ease of writing define } f(r) = \left(1 - \frac{2M}{r}\right)$$

The intrinsic metric of the shell hypersurface  $\Sigma$  is:

$$ds^2 = -d\tau^2 + R^2(\tau) d\Omega^2. \quad \text{A(45)}$$

$\tau$  is the proper time along the geodesics.  $\Sigma$  is a 3-dimensional time-like hypersurface, parameterized by the three coordinates:  $(\tau, \theta, \varphi)$ . It represents the shell with time dependent radius in co-moving coordinates.

Embedding  $\Sigma$  in the two regions is specified by functions that assign points in  $M_+$  and  $M_-$  as a function of the hypersurface coordinates  $(\tau, \theta, \varphi)$ :

$$M_+: x_+^a = X_+^a(\tau, \theta, \varphi)$$

$$M_-: x_-^a = X_-^a(\tau, \theta, \varphi)$$

These are  $x_-^a = (T(\tau), R(\tau), \theta, \varphi)$  and  $x_+^a = (t(\tau), R(\tau), \theta, \varphi)$ .

The components of the tangent vector to the time-like streamlines in the regions are:

$$M_+: u_+^a = \frac{dx_+^a}{ds} = (\dot{t}(\tau), \dot{R}(\tau), 0, 0) \quad \text{A(46)}$$

$$M_-: u_-^a = \frac{dx_-^a}{ds} = (\dot{T}(\tau), \dot{R}(\tau), 0, 0) \quad \text{A(47)}$$

Normalization gives:

$$u_+^a u_{+a} = -1 = -\dot{t}^2(\tau) f(R) + \dot{R}^2(\tau) / f(R)$$

Therefore:

$$\dot{t}(\tau) \equiv \gamma_+(\tau) = \left[ f(R) + \dot{R}^2(\tau) \right]^{1/2} / f(R)$$

Setting  $M=0$  in this expression yields  $\dot{T}(\tau)$

$$\dot{T}(\tau) \equiv \gamma_-(\tau) = \left[ 1 + \dot{R}^2(\tau) \right]^{1/2}$$

These expressions yield the transformations for the embeddings in  $M_+$  and  $M_-$ :

$$t(\tau) = \int \gamma_+(\tau) d\tau = \int \frac{1}{f(R)} \left[ f(R) + \dot{R}^2(\tau) \right]^{1/2} d\tau$$

$$T(\tau) = \int \gamma_-(\tau) d\tau = \int \left[ 1 + \dot{R}^2(\tau) \right]^{1/2} d\tau$$

$$r = R(\tau)$$

Using these in A(43) and A(44) yields the intrinsic interval in equation A(45), thus demonstrating consistency.

## Appendix B—Einstein tensor for the Humphreys interior metric

Humphreys' interior metric in isotropic coordinates:

$$ds^2 = -(1+2\Phi(t))dt^2 + (1+2\Phi(t))^{-1} (dr^2 + r^2 d\theta^2 + r^2 \sin^2 \theta d\varphi^2) \quad \text{B(1)}$$

From this we compute the Einstein tensor (using Sygne sign convention) for the interior.

$$G_t^t = \frac{3 \left( \frac{\partial \Phi}{\partial t} \right)^2}{(1+2\Phi(t))^3} \quad \text{B(2)}$$

$$G_r^r = G_\theta^\theta = G_\varphi^\varphi = \frac{9 \left( \frac{\partial \Phi}{\partial t} \right)^2 - 2(1+2\Phi(t)) \frac{\partial^2 \Phi}{\partial t^2}}{(1+2\Phi(t))^3} \quad \text{B(3)}$$

$$G_r^t = G_\theta^t = G_\varphi^t = G_\theta^r = G_\varphi^r = G_\varphi^\theta = 0 \quad \text{B(4)}$$

Since Humphreys claims  $T_{tx} = T_{ty} = T_{tz} = 0$ , we get  $\Phi = 0$ , contra Humphreys.

Also,  $T_{xx} = T_{yy} = T_{zz} = 0$ , contra Humphreys.

Humphreys' interior metric in curvature coordinates is:

$$ds^2 = -(1+2\Phi(t))dt^2 + (1+2\Phi(t))^{-1} dr^2 + r^2 (d\theta^2 + \sin^2 \theta d\varphi^2) \quad \text{B(5)}$$

Giving the Einstein tensor (Synge sign convention):

$$G_t^t = -\frac{2\Phi(t)}{r^2} \quad \text{B(6)}$$

$$G_r^r = -\frac{2\Phi}{r(1+2\Phi(t))^2} \quad \text{B(7)}$$

$$G_r^t = -\frac{2\Phi(t)}{r^2} \quad \text{B(8)}$$

$$G_\theta^\theta = G_\varphi^\varphi = \frac{4 \left( \frac{\partial \Phi}{\partial t} \right)^2 - (1+2\Phi(t)) \frac{\partial^2 \Phi}{\partial t^2}}{(1+2\Phi(t))^3} \quad \text{B(9)}$$

Since Humphreys claims  $T_{tt} = T_{rr} = T_{\theta\theta} = T_{\varphi\varphi} = 0$ , we get  $\Phi = 0$ , contra Humphreys.

This implies  $T_{tr} = T_{rt} = 0$ , contra Humphreys.

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